CHEMICAL & BIOLOGICAL WARFARE Review

LEARNING LESSONS FROM LITVINENKO

INFORMATION FROM RADIOLOGICAL INCIDENTS

BEGIN BY SPLITTING THE ATOM

HANDLING CBRN IMPROVISED EXPLOSIVE DEVICES

SOLUTIONS FOR BORDER SECURITY

METHODS USED TO PREVENT CBRN PROLIFERATION

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Chemical and biological detection

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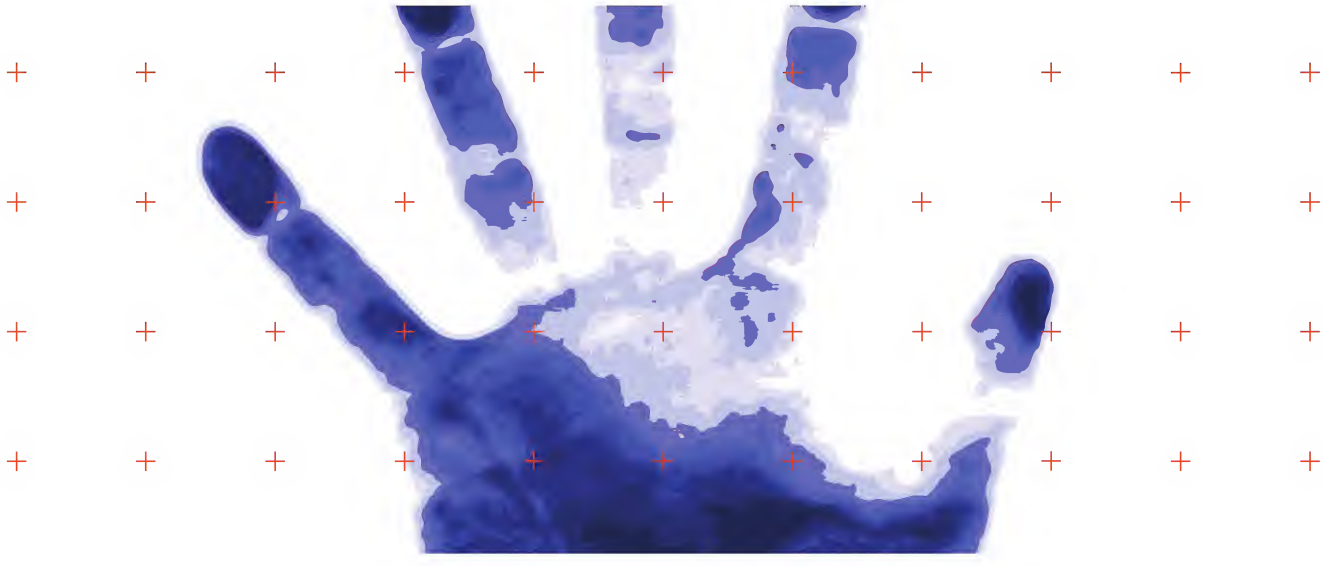

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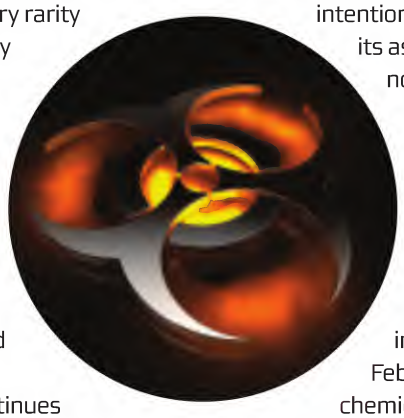
INTRODUCTION

Forward planning

Attacks using CBRN materials are rare but their potential scale is enormous. Making sure that the planning to deal with these attacks is in place is imperative. CBW Review editor, Andy Oppenheimer, hopes that lessons will be learned.

In October 2010, the UK government published a new National Security Strategy, including policies for countering the CBRN threat, described thus: "...terrorist networks continue to seek and utilise [CBRN] materials... Several factors have increased the risk: a significant increase in the illicit trafficking of radiological materials; the availability of CBRN technologies on the internet; and the acquisition by terrorists of CBRN-related material used for legitimate purposes. While there have been very few examples of non-conventional attacks using CBRN materials, the potential scale and impact of an attack makes planning for them an imperative."

It is this final point which concerns us among the various warnings and updates on terrorism – the very rarity of recorded CBRN events makes contingency planning, first-response preparedness and training, and the ordering of equipment a continuing challenge. I italicize the word 'recorded' as I believe (and have been told in personal communication) that CBR attacks have in fact occurred – such as in Afghanistan – but go unreported. In this issue we will examine improvised CBR devices and ways of detecting, sampling and – as part of IEDD – dealing with them.



Despite the current recession the US continues to spend billions on the War on Terror both in military operations and on the homeland security front. However, the UK is taking CBRN seriously, albeit on a much smaller scale. Current mechanisms include the training of thousands of emergency service personnel and key officials to deal with terrorism, including CBRN. As part of the CBRN Resilience Programme 18 sites nationwide have trained officers for a multi-agency response, supported by the CBRN response centre – which provided support during 2010 on over 100 CBRN-related incidents.

But this is taking place against a background of cuts. The gap between the 2011-12 defence budget and the cost of the MoD's planned programmes is said to be about £1 billion (US$1.6 billion). If this shortfall is not fixed the military faces more cuts, including personnel reductions at a time when even more is being demanded of our armed forces. The same will apply for homeland security with cuts made to the police force.

Human factors, particularly intelligence, remain vital in breaking terrorist networks, which for CBRN are more complex, nearly always involve Iran, and can stretch across continents. One hopes lessons will be learned from the 7/7 hearings – that MI5 could have identified the leader of the bombers as an extremist with links to terrorists just four months before the attacks. The horde of intelligence gleaned from the complex where Osama bin Laden was holed up and shot dead on 2 May 2011 will give vital clues as to the CBRN intentions and, possibly, capabilities of Al Qaeda and its associates in that direction. But that war is nowhere near over – his successor and mastermind of several major AQ bombings, Ayman al-Zawahiri, has stated an interest in acquiring and using chemical and biological weapons against the west.

Back in the UK, authorities are pre-empting dozens of attacks and the US has unearthed at least 20 in the past two years, including a Saudi student charged in February for allegedly trying to procure chemicals to make the explosive trinitrophenol for car-bomb attacks. The charge 'attempting to use a WMD' underscores the notion that a WMD may not be CBRN: the 9/11 attacks were not CBRN, but certainly were a WMD.

And community and industry co-operation will be equally vital: the Saudi student was prevented from getting delivery of his chemicals as the freight company storing them alerted the supplier and called in the FBI. Work with industries must proceed to secure CBRN materials, many of which are dual use. This is a tall order in an era of global trade, but more so in unstable regions such as the Middle East and countries such as Pakistan. As of writing, both areas were increasingly prone to insurgency or undergoing revolution. The Chinese curse of 'may you live in interesting times' may well resonate in the coming months and years.

"Despite the current recession the US continues to spend billions on the War on Terror both in military operations and on the homeland security front."

ST53 technology for specialist operators

Avon Protection demonstrated its new CBRN mask and modular SCBA system for the first time at NAVDEX 2011 in an imaginary law enforcement exercise. The ST53 combines Avon's FM53 mask with innovative modular breathing apparatus technology to provide positive pressure SCBA and/or PAPR capability for specialist applications, and includes a light and compact air cylinder that can be efficiently carried on the waist.

The FM53 mask has been specifically developed for operators requiring both positive pressure SCBA, CCBA, APR/PAPR and negative pressure capability. It has a patented twin exhalation valve that provides end users with the capability to use the mask as a negative or positive pressure respirator. This enables different threat environments to be entered without the need to change equipment.

It is available with panoramic optically-correct, flexible visors; clear, sunlight, laser and blublocker outserts; voice-projection units and inter-changeable nosecups for maximum comfort and fit. The FM53 is also interoperable with a variety of communications systems.

The new 50 series also offers a twin-filter concept with close-fitting conformal filters and self-sealing valves reducing contamination risk during filter change, as well as an electronic communication port, which is universally compatible and provides internal microphone connection to communication systems.

AVON expands operations in Maryland

Avon has expanded its operations in Maryland with a new, larger facility in Belcamp, to help the company meet a growing demand for personal respiratory protection in North America. The expansion will enable Avon to continue building its relationship with its biggest client, the US Department of Defense, at a time when demand for PPE for the military as well as law enforcement, first responders and federal agencies has increased by 650 per cent in the past three years. The new facility is the business and innovation centre, housing the marketing, product development and design departments. Many Maryland-based law enforcement agencies and SWAT teams use Avon PPE products, including Baltimore City and Annapolis SWAT and Harford, Carroll and Anne Arundel County Sheriffs' Departments.

MODULAR DESIGN FOR SCOTT'S FREEDOM FIGHTER

Earlier this year Scott Health & Safety launched the Freedom 6000, its latest advancement in gas detection. It supports the detection of toxic and combustible gases, incorporates a universal transmitter into a fixed gas detection system, simplifying maintenance and reducing training costs.

The system combines Scott's advanced sensor technology with a modular design to enable simple component replacements and field upgrades and comes with a suite of accessories for customising the system.

As part of Scott's Freedom series, Freedom Direct detects combustible gases and carbon dioxide using infrared or catalytic bead sensor technologies. The detector delivers information on gas concentrations directly to a Scott controller without the need for a transmitter, reducing the cost of a point of combustible gas detection by 40 per cent. When local display is required, Freedom Direct can be easily upgraded to Freedom 6000.

QUICK DETECTION FOR INSPECTORS

Instrumentation specialist Quantitech featured two new detection technologies at Counter Terror Expo 2011 – the Gasmet DX4030 multi-gas analyser and the TeknoScan TSI-3000 banned-substance trace detection system. The DX4030 is able to detect and quantify almost any gas and is therefore well suited for cargo safety, emergency response or fire investigation. As a pioneering portable FTIR multi-component gas analyser, the Gasmet DX4030 enables operators to measure multiple components simultaneously, including TICs, CWAs and other potentially harmful substances.

The TeknoScan TSI-3000 is a highly sensitive and selective portable system capable of simultaneously detecting target substances from a library of up to 50 separate compounds. It provides complete analysis of samples in three minutes or less and speedy measurements for customs inspectors and freight organisations. Of note is that this technology does not rely on vapourised samples and includes advanced sampling tools that make it possible to test almost any container, vehicle or package.

Simplifying handling

FLIR Systems of Portland, Oregon has introduced a new Multi-Modal gas chromatograph mass spectrometer (GC/MS) Instrument multi-modal system, the Griffin 460, for liquid, solid and vapour samples while also providing continuous, direct air monitoring.

The Griffin 460 is claimed to be the only mobile GC/MS to provide this range of sample introduction in a single system that also enables MS/MS. It is intended for field-based forensics and other mobile laboratory applications, as well as for integration into facility air handling systems.

During continuous monitoring applications, the Griffin 460 can be programmed to alert at the presence of selected chemicals in indoor and outdoor environments for near real-time detection and identification of a chemical agent release. It simplifies sample handling through the use of very lightweight accessories such as a fully-automated purge-and-trap accessory and the Griffin X-Sorber, hand-held vapour sampler with thermal desorption capabilities.

Griffin products have been in use with US military, DoD, DHS and other domestic and international agencies for explosives, narcotics and other chemical target detection and confirmation.

Radiation detection speeds over to boat patrols

Earlier this year Thermo Fisher Scientific announced an original equipment manufacturing partnership with Brunswick Commercial and Government Products to equip patrol boats with radiation detection systems. The detector-equipped boats are designed to spot and prevent the threat of radioactive materials from covertly entering a country through harbours and ports.

Protect-US to expand Bruker product range

Bruker Detection Corp. has acquired the radiation detection instruments business of Protect-US Inc. Bruker intends to move the new business to its operations in Massachusetts.

William Dunn, founder and CTO of Protect-US, received the Pacesetter Award from Argonne National Laboratory for his part in developing the PROTECT programme installed at various US sites, using advanced technologies to detect and identify radiological hazards, weapons and devices.

Protect-US radiation detection systems and integrated communications solutions will expand the Bruker product range to meet homeland security requirements for the detection of concealed nuclear weapons and for isotope identification. The acquired products will be marketed as Bruker Radiation Sentry® detection systems.

An advantage of Protect-US detection products is their ability to differentiate in most cases naturally occuring radioactive materials and medical treatments from possible terrorist threats, as well as likely threats from non-threats within persons, containers and even moving vehicles. The systems are engineered into various customisable instrument platforms – portable backpacks, rapid deployment bollards or stanchions, fixed-location systems at entrances, roadways, rail lines, border crossings or ports, as well as vehicle, aircraft or helicopter-mounted systems. Protect-US systems can be provided as complete turn-key solutions that communicate and report actionable information to government agencies.

BRUHN NEWTECH SUPPORTS NATO FORCES

Bruhn NewTech has won a contract from the NATO C3 Agency to supply 25 licenses of its CBRN-Analysis specialist software to the NATO deployable forces. The company will support the forces' advanced operational readiness and their capability and capacity in CBRN threat avoidance and impact mitigation, in line with the latest NATO operational standard ATP-45(D). The aim is to provide military commanders with CBRN situational awareness of the battlefield to sustain effective operations in hostile and high-risk environments. The contract includes software support and maintenance, software updates in accordance with the ATP-45 standard and continued specialist training and exercise support, in the field and at the German NATO School.

Developing drugs for acute radiation syndrome

The US Department of Health and Human Services' (DHHS) Biomedical Advanced Research and Development Authority (BARDA) awarded contracts for advanced development of drugs to treat acute radiation syndrome (ARS) to Aeolus Pharmaceuticals Inc., and U.S. Biotest Inc. The aim is to address the skin and lung injuries that arise from acute exposure to high levels of ionizing radiation – the type that results from a nuclear blast.

The Aeolus contract is valued at $10.4 million for the first year and can be extended for a total of five years and up to a total of $118.4 million. Aeolus is developing a broad-spectrum anti-oxidant drug, AEOL 10150, which was originally designed to reduce the damage caused by radiation during cancer treatments. The drug will be developed for use in treating pulmonary ARS or lung-ARS.

As part of the DHHS' strategy for radiological and nuclear threats preparedness, the US Biotest contract, valued at $4.5 million for the first 16 months, could be extended for five years and for a total of $14 million. The contract with US Biotest supports advanced development of DSC127, a drug applied to the skin to help body tissue heal after being exposed to ionizing radiation. BARDA has awarded contracts to develop medical countermeasures to treat neutropenia, an abnormally low number of white blood cells, as well as contracts to develop drugs that bind radioactive materials in the body and for biodosimetry devices. These devices measure an individual's level of radiation exposure after a nuclear incident.

Touchdown for Smiths Detection in 2011 Super Bowl protection role

Smiths Detection supplied detection systems and training to multiple local and national security agencies tasked with security at the 2011 US Super Bowl as well as for other events and venues associated with the American Football championship game.

Leading up to the event and on game day, teams of law enforcement and counter-terrorism officials used Smiths Detection tools for air monitoring, entrance screening and response to potentially unknown chemical or biological threats.

Smiths Detection hosted ten days of free workshops for emergency response teams involved in the event. Sessions were designed to teach the teams sampling and operational techniques, how-to-use functions exclusive to Smiths Detection systems, and how to create site-specific chemical libraries to facilitate quicker identification of unknown substances.

Smiths have also provided threat detection and security screening systems for the Olympic Games, the FIFA World Cup and Pan American Games as well as the G-20 Summit and UN Congresses.

REALISTIC 3-D SIMULATIONS

SAIC's new Virtual Command Simulation Environment powered by On-Line Interactive Virtual Environment (OLIVE) software enables realistic, 3-D multithread simulations.

These include a first-responder emergency medical simulations, featuring triage and medical team training in response to a mass civilian casualty event.

OLIVE is a new way to integrate simulations into a common environment for real-time and persistent operational pictures for complex simulations and training.

Materials expert extends range of combat suits

Aero Sekur, which specialises in the use of advanced composite materials for military and NBC, has announced its latest integrated range of ground defence apparel, including respirators, NBC and combat suits, battle dress uniforms, sniper suit poncho, over-garments, personal camouflage systems and camouflage nets.

Inflatable field shelters and ColPro for tents, vehicles and ship-based protected environments are also supplied, plus fuel tanks and parachutes for military applications.

Among the latest innovations is a lightweight, low-cost, gas alarm incorporated into the suit to alert the wearer to an NBC attack. Aero Sekur is also trialing technology to embed sensors into combat apparel materials.

Also new is the Spectro sniper poncho, which at 0.4kg is said to be one-third lighter than its nearest competitor product, with a 95 per cent reduction of IR signature for its weight, giving it a significantly lower thermal signature.

Aero Sekur is a specialist supplier of safety systems and advanced flexible materials to the aerospace and defence markets. Formed in 1993 by the merger of Irvin Aerospace and the Sekur division of Pirelli it brought together 40 years of experience in parachutes, NBC equipment, aircraft fuel tanks and complex flexible structures NBC suit.

ROBOTS IN FUKUSHIMA

Andy Oppenheimer reports on how remotely-controlled vehicles are helping to monitor radiation levels inside the Fukushima Daiichi plant in Japan.

Images: iRobot

Left-to-right: iRobot Warrior 710s being prepared for deployment to the Fukushima plant. Packbot 510s are equipped with HazMat payloads which can detect temperature, gamma radiation, explosive gases and vapours, and toxic chemicals. The Warrior 710 is much larger and stronger than the Packbots; it can carry payloads of up to 68 kg and the robot arms can lift over 90 kg.

The series of explosions and cooling systems failure at the Fukushima Dai-1 nuclear plant in Japan following the 9.0-magnitude earthquake and devastating tsunami in March have produced intense levels of radiation. These have made it increasingly dangerous for human rescue workers to operate inside the plant. With many workers already contaminated, the need for stand-off working was imminent and remains paramount. A fully PPE-suited HAZMAT team will absorb an entire year equivalent of 'permitted' radiation after spending only five minutes in the plant.

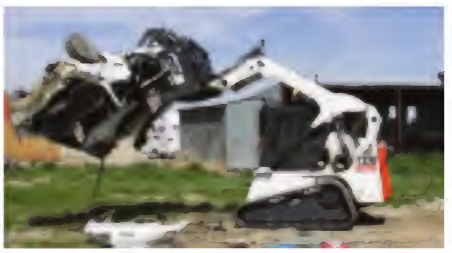
Enter the robots: on 19 April, remote-controlled vehicles made by iRobot were brought in by the Special Ops group of Japan's Self Defence Forces to provide a better picture of conditions deep inside the shattered reactor buildings, to clean up wreckage, and investigate radiation levels. iRobot have trained Japanese defence personnel to control the robots remotely from a protected vehicle.

The iRobot Packbot is well known for its use in remote-controlled explosives ordnance disposal (EOD) operations in military arenas such as Afghanistan. The Packbot 510 and Warrior 710 are designed to cope in very hazardous conditions; they can survive being dropped nearly two metres down onto a concrete surface, and will go on functioning even after being totally submerged in water (of great value in this particular setting).

In this operation the Warrior 710s are being used as robotic firefighters – dragging hoses of cooling water into the hot zones – and as such will undergo a unique trial in an application beyond EOD and other military tasks. The machines have undergone amendments and added components to make them capable of shifting debris, mapping radiation hot spots, and to move and navigate around the building interiors.

As in EOD, the robot cameras stream live video back to the operators, enabling them to steer the robot using game-style controls. With a wireless range of over 600 m, they can climb over rubble (and there's plenty of that inside Fukushima) and climb stairs. And as in the latest EOD applications, the Warrior 710 can act as a 'mothership' robot by carrying the smaller Packbots and deploying them through windows into structures and enclosed or restricted spaces. Once inside No. 3 reactor building the robots detected and recorded extreme levels of radiation: between 28 and 57 millisieverts per hour (only 250 millisieverts per year is the maximum allowed for a reactor worker).

Another robot company involved at Fukushima is QinetiQ. It has sent in the TALON, the surveillance and reconnaissance Dragon Runner and the BOBCAT – a plough-sized, heavy-duty lifting machine – that has a forklift and jackhammer for hauling debris and penetrating very bulky rubble. All three robots can be operated remotely from distances of 1,100m and 1,400 m. Similarly to iRobot, TEPCO employees trained by QinetiQ then analyse the video streams of the debris pick-up.



Bobcat loaders from Qinetiq are being used to shift rubble inside the stricken plant

The iRobot Packbot is well known for its use in remote-controlled explosives ordnance disposal operations in military arenas such as Afghanistan.

EnVision

Mobile CRN Monitoring & Warning System

EnVision is an Ad-Hoc CRN monitoring and warning system enabling CRN detection at a certain event or area without having to install a fixed detection system. It provides real-time information at the scene concerning CWA (Chemical Warfare Agents), TIC (Toxic Industrial Chemical) and Radiation threats. EnVision allows creation of a complete wireless detection network, enveloping the main hazard area within minutes of arrival to the site.

Key Features

- C4I-compatible network within minutes
- Full detection capability in one unit
- Intelligent hazard management software
- Rapid deployment
- Built for extreme conditions

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ICDs SPORADIC BUT DEADLY

Andy Oppenheimer assesses a growing threat from a plentiful supply of commonly available materials.

Left: Packing an abandoned chemical warhead from leftover Iraqi stocks prior to complete OPCW disposal. OPCW. **Bottom left: 140th Services Flight, Colorado Air National Guard simulates casualty evacuation during an operational readiness inspection.** TSgt Wolfram M. Stumpf. **Bottom right: Drill for casualty response by US Army Reserve 357th Chemical Company (DECON). Most 'white powder' attacks are hoaxes, but speedy decon would be necessary for a confirmed toxic contaminant.** US Army, SSgt Brian Lehnhardt.

In April-May 2010 in Kunduz, northern Afghanistan, at least three girls' schools were attacked by Taliban bottle-bombs of organophosphate. There is growing evidence – albeit often not widely reported – that insurgents and terrorists are converting conventional IEDs into improvised chemical devices (ICDs) and other forms of chemical or incendiary-enhanced attack.

When used in theatre, ICDs deny access and forward movement to troops, producing contamination that needs to be detected, assessed and cleared to protect further harm to troops and civilians. Once ICDs have been used, preparation must be made to deal with immediate injury and long-term syndromes and expensive cleanup. In the civilian arena economic damage would be caused by denied access of prime real estate and vital infrastructure such as transit systems, as well as enhanced fear and mayhem over and above an 'ordinary' IED attack.

ICDs are less likely to contain weapons-grade chemical warfare agents (CWAs), although there have been attempts to make improvised versions. Popular mixes are hydrogen cyanide and organophosphate (see below). Unlike radiological or biological raw materials for weapons, household and industrial chemicals are in plentiful supply. Many millions of tons of civilian-use toxic industrial chemicals are in transit around the world, most of which, unlike CWAs, are unregulated.

Improvised incendiary devices

Incendiary enhancement to IEDs has become a common terrorist methodology. The attempts to car-bomb a London nightclub and Glasgow Airport terminal in June 2007 involved vehicles containing gas canisters. These improvised

SCOTT SAFETY

Scott Safety, formerly Scott Health and Safety, are world leaders in the design and development of Respiratory Protection Equipment (RPE). We have a detailed understanding of the physiological and physiological burden RPE can place on users. That is why we test in the field. And we apply what we learn there – as well as emerging research and technologies to every design to ensure capability, functionality and comfort. Irrespective of whether your requirement is for CBRN protection, Breathing Apparatus for EOD, USAR, damage control, fire-fighting or for specialist applications Scott can meet your requirements – comfortably.

A raid on an insurgent weapons cache in Fallujah, Iraq yielded potassium cyanide and other chemicals and explosives. US DoD.

incendiary devices (IIDs) would have been devastating had the mobile phone detonation in each vehicle succeeded, and the windows opened – but as it was there was not enough oxygen to trigger the devices.

The ingredients were readily available: the two bombers had purchased large amounts of nails, fuel and gas canisters without attracting the attention of the police or intelligence services. The men had at least two more vehicles and more supplies of gas, petrol and electronic detonators. Ahmed, an Indian-born engineer who spent months in India working on a design for the car bombs, modelled the devices on those used by insurgent forces in Iraq, but the tests he carried out in India used fuel that was more flammable than that found in the UK.

The vehicle-borne IED (VBIED – car bomb) left by a Pakistani-born American in Times Square, New York City on May Day 2010, which failed to detonate, included gasoline canisters to enhance its incendiary effect. The explosive charge and detonators were of inadequate quality but had the vehicle not been spotted, a partial explosion at least would have injured dozens of passers-by at the city's busiest crossroads. Following the incident, President Obama requested full funding for a CBRN detection ring around Manhattan and more federal support for explosives detection and funding for the New York Police Department's CCTV presence. The attack highlighted the potential threat of a non-conventional terrorist attack outside of a combat zone.

IIDs have also featured in recent dissident Irish Republican attacks in Northern Ireland, which have increased in the past two years. In April 2010 a VBIED left outside a police station in Newtownhamilton, Co. Armagh, contained gas-filled flammable containers as well as an IED, which was defused. A second VBIED abandoned at the same target ten days later exploded, injuring three and damaging nearby buildings.

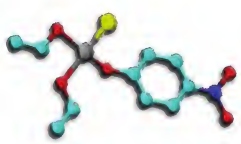
Legacy sources

Legacy munitions made for, and used in, previous conflicts have added to the growing arsenals of insurgents, especially in Iraq. Although successive UN inspection teams and occupying US forces have cleared much of Iraq of CW ordnance, the sheer number of abandoned chemical shells may provide the means for ICDs. Accidental chemical contamination is also a problem: in September 2009, two British EOD officers were contaminated with mustard agent after disposing of a CW munition washed up on to the Welsh coast.

Iran as a known state sponsor of terrorism is estimated to possess supplies of CWAs, and it is suspected that the Libyan Gadaffi regime still holds sizeable stocks. Caches of Iranian-origin chemicals, including potassium cyanide, have been discovered by NATO troops in Lebanon and Iraq. Rockets from Iran which can be CW-adapted are already in use by Hezbollah and other insurgent groups operating against Israel, as are explosively formed projectiles from Iran by the insurgents in Iraq against coalition forces and Iraqi security and police. Infiltration of laboratories, organisations and plants is a growing threat and varies according to security measures in different countries and instability or corruption.

Classic SLUDGE symptoms of immediate organophosphate poisoning

Salivation
Lacrimation
Urinary distress
Diarrhoea
Gastrointestinal upset
Emesis



(US EPA)

Organophosphate molecule

Legacy munitions made for, and used in, previous conflicts have added to the growing arsenals of insurgents.

Evidence of chemical attacks

As Hazmat is unstable, difficult to manufacture, store and transport, a terrorist group may therefore choose to mount an attack on a shipment of chemicals or chemical plant rather than try to fashion and deploy ICDs. Chemicals used in IEDs also tend to burn out after detonation and may dissipate depending on weather conditions and location. While it is hard to assess whether fatalities are caused by the blast or the added chemicals, terrible injuries may still result – many long-lasting – as occurred during hijacked chlorine tanker incidents in Iraq from January to April 2007. In the sixth incident, in Ramadi, 20 were killed and 80 injured. The M.O. involved hijacking tankers containing chlorine gas cylinders, and blowing up a petrol-enhanced explosive charge.

In Afghanistan reports of Taliban attacks on three girls' schools in Kunduz with bottle bombs surfaced in April-May 2010, resulting in 32 schoolgirls being hospitalised. Very simple weaponisation was used: one victim saw a man in black clothes cover his face with a cloth and throw a bottle near the school. The girls reported smelling something sweet, then developed classic symptoms of immediate organophosphate poisoning: salivation, lacrimation, urinary distress, diarrhoea, gastrointestinal upset and emesis (SLUDGE). Some became unconscious or developed cyanosis, and hospital lab blood tests confirmed organophosphate poisoning.

Other unsubstantiated reports verbally communicated to me by serving US Army personnel experiencing IED attacks

THE **ULTIMATE PROTECTION**

As a wordwide R&D leader in CBRN footwear, hand wear and respiratory protection, AirBoss-Defense understands the operational requirements of its clients. For the past 40 years, it has created innovative user-oriented designs and promoted the use of the utmost advanced technical materials in millions of products sold in over 25 nations.

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Members of the Mountain Home Air Force Base Bioenvironmental Response Team approach a car covered in white powder, later identified as fire extinguisher residue.
SSgt Christopher Campbell, USAF.

in the Afghan theatre indicate after-effects of organophosphate exposure based on their symptoms. As precursor chemicals for nerve agent, organophosphates are harmful in their own right and as they are used in insecticides such as Malathion, are easy to procure. Several other reports of devices and poisonings in theatre involving Malathion have surfaced involving cyanide, ammonia and rat poison, which have similar characteristics to nerve agent. Acetylene and nitric acid have also been suspected as ingredients in homemade IEDs deployed by the Taleban.

Lone wolves

An abiding and increasing threat in CBR is the 'lone wolf' – individuals with a fanatical belief system or grudge, who construct homemade labs in the garden shed to manufacture the means to hurt those they hate (which in some cases can be anyone). Nonconventional weapons appeal to such maladjusted individuals. Lone-wolf (which can sometimes be 'lone nut') cases are prevalent in the US, where white supremacism and racism is undergoing a revival. The Oklahoma bomber, Timothy McVeigh, who perpetrated the worst terrorist atrocity on US soil before 9/11, was a classic example of this.

Several reports of devices and poisonings in theatre involving Matathion have surfaced.

A noted example, William Krar, a member of the 'New Jersey Militia', was sentenced to 11 years in prison in 2004 for possession of 800g of pure sodium cyanide (enough to kill everyone inside a 10,000-sq m building – around 6,000 people) and stocks of precursor chemicals, including hydrochloric, nitric and acetic acids. He had also stockpiled 500,000 rounds of ammunition; 60 functional pipe bombs; a homemade landmine; grenades; 67 pounds of ammonium nitrate; 66 tubes of nitromethane (racing car fuel); a remote-controlled briefcase ready for explosives insertion; military detonators; trip wire; blasting caps; and cases of syringes containing military atropine (nerve agent antidote).

However, 'lone jihadi' ICD threats are also emerging. In February 2011 a Saudi chemical engineering student, Khalid Ali-M Aldawsari, was arrested in Texas charged with 'attempted use of a weapon of mass destruction' following his alleged attempted purchase of 1.3 gallons of phenol, which can be used to make the explosive trinitrophenol, as well as attempts to procure nitric, sulphuric and other acids, allegedly to car-bomb targets in Texas and New York City. The difficulty in tracing and apprehending lone wolves often stems from their remote location or lack of police record, or non-affiliation to a terrorist or extremist group on the intelligence and police radar.

Countering the chemical threat

Harnessing local knowledge, acquiring intelligence and working with local security and civilian bodies can significantly help to break terrorist supply chains for a variety of weapons and components. But in the case of chemicals the supply is so widespread and unregulated that national chemical industries – which are often global corporations – must take responsibility for security. While possibly not intended for ICDs as such, but for IEDs, when Khalid Ali-M Aldawsari ordered materials from a chemical company, Carolina Biological Supply of Burlington, N.C., for $435 the freight company storing them returned the order to the Burlington supplier and called the police. Within weeks, federal agents had traced Aldawsari's other online purchases and his extremist internet postings. Many examples of acquisition of legitimate, plentiful sources of chemicals are not easy to trace unless a terrorist and/or criminal link is suspected and action taken – proving that not only intelligence, but also citizen and corporate awareness, is vital in the war on terror.

INCREASED VIGILANCE HANDS KEYS TO FUTURE SECURITY

On 24 January 2011 at 16.32 hours a shrapnel-filled improvised explosive device (IED) blasted through the international arrivals hall at Moscow's Domodedovo Airport, killing 36 and injuring over 130. On video footage none of the emergency responders rescuing and treating the casualties can be seen wearing protective clothing or carrying CBRN detectors. It appeared the authorities assumed the explosion was from a conventional IED, despite Chechen separatists having a history of attempted radiological attacks. Andy Oppenheimer looks to future threats with past incidents in mind.

When an IED goes off anywhere in the world, it may not appear obvious it has a nonconventional component, especially if it is a radiological dispersal device (RDD) rather than an improvised chemical device (ICD) which would cause characteristic burns, respiratory distress and possibly paralysis. Such added elements would add substantial challenges to the already formidable task of response to an IED attack. Even a small-scale chemical or radiological attack would not only be costly in terms of lives lost, fear engendered, and long-term health effects, but would necessitate expensive clean-up operations and loss of economic viability.

Modelling the effects

Effects depend also on whether the radioisotope in the RDD emits alpha (potentially lethal when inhaled or swallowed), beta (moderately penetrating) or gamma (penetrating) radiation. Speedy detection of alpha emitters such as uranium compounds, plutonium and polonium poses special challenges. These

Handheld detector to alert to sources in the urban environment.
Dr Stephanie Bloomer

isotopes produce short-range radiation which can be lethal when even tiny amounts are inhaled or ingested.

Opinions vary on the effects of RDDs and it remains a controversial area. Depending on the nature and size of the RDD, the result could be mainly disruption and costly clean-up with minimal health effects, to high-level radiation causing death or radiation injury. Low-level radiation may produce long-term health risks such as cancer and multi-symptom syndromes. But it is argued that RDD-making would be too dangerous as bombers fabricating unshielded radioactive materials into IEDs run the risk of frying before they get to carry out even a suicide attack.

Thousands of sources are classified as high risk because of their high activity, and include Cobalt-60, Cesium-137, Iridium-192, Strontium-90 (beta), Americium-241, Cf-252, Plutonium-238 and Radium-226. Polonium-210, an alpha emitter, is much rarer but nevertheless created a radiological dispersal event (RDE) when used to poison Alexander Litvinenko in London in December 2007.

Much also depends on the variables obtaining at the time of explosion: meteorological models such as produced by the National Oceanic and Atmospheric Administration can plot the path of a dust plume and its dispersal and disposition. Thus the fallout pattern can be assessed and areas evacuated and decontaminated where necessary – depending on the policies of the government concerned regarding radiation risks to people and property.

Such a scenario can be plotted for noted attacks. For example, had the massive 1,200kg ammonium nitrate/Semtex bomb detonated by the IRA in the City of London in April 1993 contained a sizeable amount of radioisotope (such as a spent fuel rod containing plutonium and other daughter products), dust would have travelled in a northerly path on the prevailing southerly wind on the day, with deposition of radioactive fallout mainly along a tract of north London and possibly onto Liverpool Street station (see illustrations), then further north. Had the

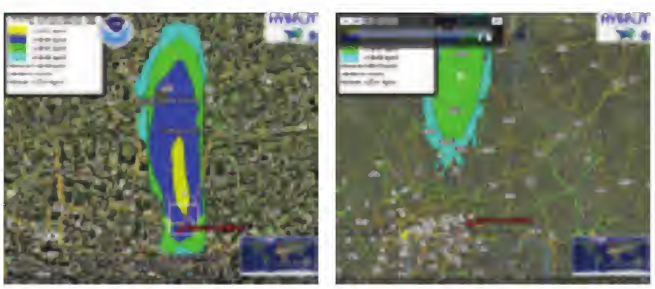
day been warm with no wind, fallout would have been mainly concentrated in 'hot' clumps within the City of London.

Pakistan shipment scenario

Of both established and new nuclear weapons states, Pakistan is high on the list of nuclear terrorist risk areas. Despite improved weapons security – for example, activation codes are now installed (permission action links), its facilities and institutions are prone to infiltration. An attack on a civilian facility or shipment of highly radioactive spent nuclear fuel (SNF) is a considered scenario, such as one devised by the US Henry L. Stimson Center in 2007, which assesses the possibility and effects of a 'hybrid sabotage' on a radioactive consignment truck transport using penetrative anti-tank weapons. Pakistan has become more unstable since then. There were 340,000 tons of spent fuel in the world by 2010 and an estimated 457,000 tons by 2020.

Terrorists acquire information on the SNF movement from an insider. After months of planning and weapons acquisition they carry out multiple missile firings, using shaped-charge and other tank-penetrating weapons, on a SNF truck stationed for repair at a petrol station in a congested part of a major city, Karachi. This causes a breach in at least one of the casks, releasing 10 per cent of gamma-emitting radionuclides in the heart of the city and triggering explosions and fires at the station for several hours. The debris cloud rises over 500 m high, further elevated by fire.

Contamination of buildings within less than a square km due to radionuclide release from just the breached flask containment may not reach the level to cause acute radiation syndrome within this area. There could be more deaths from the initial blast and fires, but survivors in the highest dose area would spread contamination. The remaining 90 per cent of cesium still contained in the breached SNF flask would expose first responders to excessive radiation levels. Type B SNF flasks are designed to maintain their integrity under fire at 800°C for 30 minutes, but a hotter or longer-lasting fire would cause them to fail. The fire could also be caused by crashing a hijacked petroleum tanker at the incident site.



Left: Dust dispersion 10 minutes following the IRA Bishopsgate bomb in April 1993, based on weather patterns on that day. Right: Dust area dispersion north of the London area 60 minutes after the Bishopsgate bomb explosion.
NOAA Air Resources Laboratory.

Geiger counter

The illicit trade of nuclear and radiological materials is recorded by national police and border security and cases of arrests, stings and lost sources notified – when the authorities choose to do so – to the International Atomic Energy Agency (IAEA) nuclear smuggling database. This does not, however, include third-party shipments, false accounting and bills of lading, sanctions-breaking, export rule evasion and other illicit trading practices by networks of companies or individuals involved in smuggling nuclear materials – many of them dual-use – across national and continental borders.

To counter this illicit trade the emphasis is increasingly on sharing intelligence across borders, which must be assessed for its reliability and credibility. Project Geiger is a joint initiative between Interpol and the IAEA, launched in 2005 with data and financial support from the US Department of Energy and National Nuclear Security Administration to gather comprehensive data on nuclear and radiological materials trafficking. As well as assisting with international investigations, Project Geiger shares expertise, co-ordinates analyses, prevention and response.

The project integrates terrorism, crime, and nuclear issues within a larger strategic context. Patterns and trends, potential risks and threats, routes and methods, and weaknesses and vulnerabilities are included in analytical reports which are posted on the secure Interpol websites and are available to officials by request. Interpol would deploy an incident response team to member countries experiencing a radiological incident to assist in criminal investigations, through searches of Interpol's databases of nominal data, fingerprints, DNA profiles and travel documents.

Left: Looted yellowcake barrels brought from local villages to the abandoned al-Tuwaitha nuclear facility. Right: Radioactive sources discovered by NEST team on an Iraq tour of duty. NNSA.

Assessing the trends

According to Project Geiger data records, incidence of trafficking spiked in 2005 (around 400), with 2,400 cases recorded from 2002 to the end of 2010 – the year with the lowest number (138). Interpol believes that the dearth of radiological attacks is somewhat surprising given the number of interdictions. But Project Geiger focuses on criminal rather than state proliferation incidents, which are more the IAEA's concern. Information is often sensitive and from intelligence or informant sources which must be protected, so non-incident data is difficult to obtain. There are therefore a limited number of events from which to draw full conclusions.

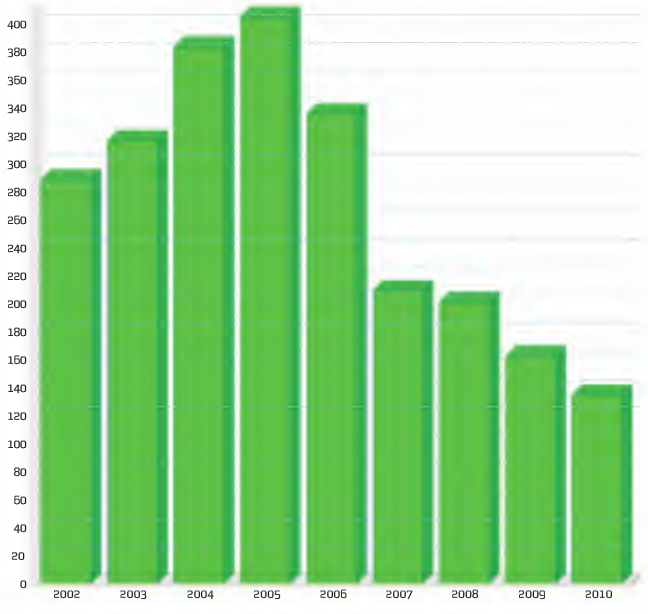
Transporting significant quantities of materials for a viable device is also problematic, as some sources are heavy and detectable. To date many trafficking incidents have involved small amounts – grams rather than kilos – some of which have nevertheless set off scanners at border checkpoints. Much depends on whether nuclear states acknowledge that material is missing from their facilities – both military and civilian. It is well nigh on impossible to ascertain if and when they have secretly provided it to other governments or non-state actors.

INDs – still confined to Hollywood?

A notable trend is that terrorists and traffickers have not yet effectively connected and that use of radioactive materials has mostly not been by terrorists but in warfare, such as tank-penetrating weapons containing depleted uranium. Terrorist deployment of an improvised nuclear explosive device (IND) is noted as unlikely without state support or source – with deep infiltration of facilities and military institutions necessary, as well as the massive logistical operation of moving large amounts of materials through unguarded land and sea borders without detection. Only three instances of trafficking seizure of weapons-grade uranium are recorded by Interpol, all in Georgia, with the FSU still the region with the largest number of incidents. Among the panoply of CBRN threats the IND threat remains very low probability, but the catastrophic result of exploding even a small nuclear device will ensure it will be taken seriously by the US authorities, who since 9/11 remain concerned with planning for 'high-effect' terrorist events.

TABLE OF ISOTOPES

Beta emitters	Alpha emitters	Gamma emitters
Cesium-137	Plutonium	Cesium-137
Cobalt-60	Uranium primer	Cobalt-60
Strontium-90	Polonium-210 (difficult to detect)	Radium-226
Technetium-99	Depleted Uranium	Technetium-99m
Iodine-129 And Iodine-131	—	Iodine-131
• Hydrogen-3 (Tritium) • Carbon-14 • Sulfur-35 (difficult to detect)	—	—



Project Geiger. Interpol, courtesy of Walter Lippert.
Number of cases involving criminal trafficking and other activities concerning radioactive materials outside of regulatory control recorded in the Interpol Project Geiger database per year, 2002 to 2011, based on information from open sources, police reporting and IAEA official reports. There were 2,400 cases reported to Interpol from 2002 to end 2010.

NBC 2012

SYMPOSIUM ON CBRNE THREATS: HOW WILL SOCIETY COPE?

Plans are well underway for the NBC Symposium scheduled to take place from 11-13 June 2012 in the beautiful location of Turku in Finland.

A comprehensive symposium programme and exhibition set in a stunning environment in Finland's oldest city.

The objective of the symposium is to provide an interdisciplinary forum for discussions on issues related to chemical, biological, nuclear, radiological and explosives defence for decision makers, experts, professionals, security officers, military planners and scientists in the fields of CBRNE defence and security.

Preliminary topics of the symposium

- Preparedness in society
- International co-operation
- Management of the risks of nuclear power
- Detection, identification and analysis
- Protection and decontamination
- Medical preparedness for CBRN threats

Papers

Participants are encouraged to submit papers for oral presentations as well as posters. The deadline for papers is 28 February 2012. Further information will be available on the NBC 2012 web site.

What the attendance fee covers

The conference fee will be published on the symposium web site in the near future. A reduced fee will be available for persons registering before 1 March 2012. The registration fee includes:

- admission to the paper and poster presentations and the exhibition
- delegate's bag containing conference material
- lunches and coffees
- welcome reception on Monday, 11 June 2012
- an excursion on Tuesday, 12 June
- symposium dinner on Wednesday, 13 June

The fee does not include accommodation or the cost of exhibition space.

An interdisciplinary forum for discussions on issues related to chemical, biological, nuclear, radiological and explosives defence for decision makers, experts, professionals, security officers, military planners and scientists in the CBRNE fields.

SYMPOSIUM VENUE

The city of Turku is an important educational, cultural and commercial centre in Finland. Dating back to the 13th century this stunning medieval location is the oldest city in Finland and was the capital of the country until the early 19th century. It's importance remains today and in 2011 it has been designated as one of the European Capitals of Culture.

The symposium venue, the Sokos Hotel Caribia is just 1.5 km from the centre of Turku and is within walking distance of the railway and bus station. The hotel is close to main roads and is less than two hours from Helsinki. This spa hotel has six restaurants and bars; the spa features eight different pools, indoor and outdoor. For those wishing to combine business with pleasure the Sokos Hotel Caribia offers a comprehensive range of spa treatments and sports facilities including badminton, volleyball, basketball, tennis and mini-golf. Several other hotels are available in the city.

Turku can be reached by ferry from Stockholm as well as by air from Helsinki, Stockholm and Copenhagen. There are also several daily train connections from Helsinki and Tampere.

THE SYMPOSIUM ONLINE

Regularly updated information about NBC 2012 will be available on the symposium website, including:

>> a link to the registration form
>> instructions for papers and posters
>> detailed information about accommodation
>> the final symposium programme

www.nbc2012.org

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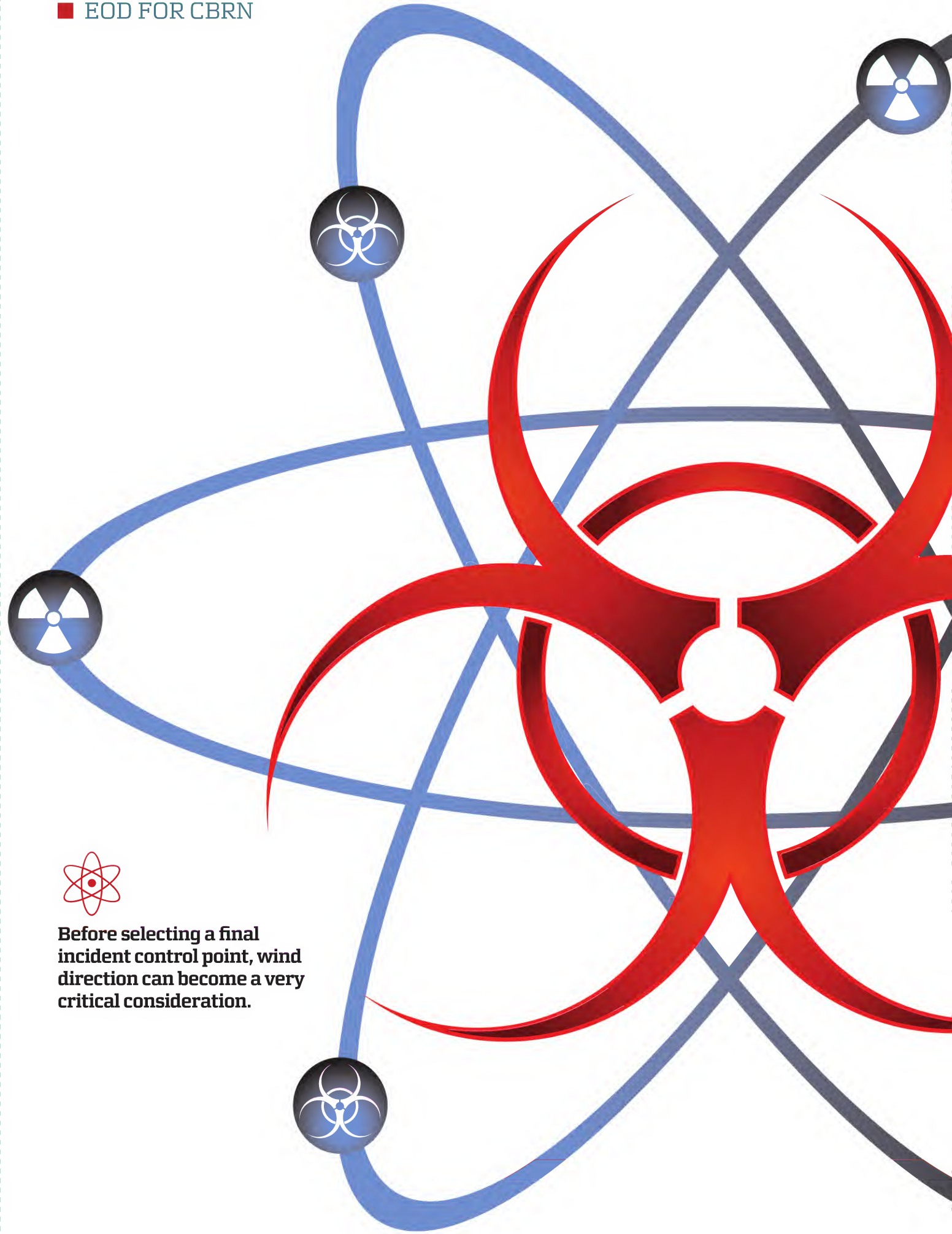


Before selecting a final incident control point, wind direction can become a very critical consideration.

BEGIN BY SPLITTING THE ATOM

Peter Daly, National CBRN Lead, Republic of Ireland, examines principles for the ultimate EOD: rendering safe CBRN devices.

To begin at the beginning – the Rutherford gambit is a good principle on which to base an investigation of a suspect CBRN IED. However, rather than splitting the atom as the great physicist Ernest Rutherford did, the aim is to split the chemical and biological away from the atoms of radiological and nuclear. IEDs have few enough advantages – but one you could attribute to a radiological or nuclear IED is that they are usually readily detectable. The more nuclear they are, the more detectable they become. So, armed with a reasonable quality radiation detector you can classify the suspect IED into R or N.

Detecting giveaway radiation

If you buy quality and get a hand-held, ruggedised microprocessor-controlled radiation detector with integrated sensors for gamma and neutron radiation, and highly sensitive probes for the detection of small amounts of radiation, you can quickly classify into alpha (α), beta (β), or gamma (γ) radiation. More importantly you can determine just how deep in the mire you may be!

Few if any of us think 'wind direction' in the early response to a call-out. But before selecting a final incident control point, wind direction can become a very critical consideration. So, with just one radiation test you can be upwind of what you are fairly certain is, or is not, a radiological device – the ubiquitously termed 'dirty bomb'.

X-ray imaging

Leaving the top-of-the-range improvised nuclear device to the big boys with the big toys, the next step to consider is to try to get an X-ray of the CBR IED. Here we have some good news in the form of the Pixium Portable System from Logos Imaging. Designed around the Pixium 342 x 432m, it provides an image with a massive 2372 x 3000 pixels. The normal built-in WiFi link is replaced

Remote x-ray with x-ray source enclosed to facilitate decontamination.

with a mil spec long-range bi-direction link.

It can be used with standard X-ray sources and with high-detection quantum efficiency, produces remarkable detail in near real-time. It takes about 10 seconds for a 16-bit picture to come back. The bi-direction delivers a range in excess of 500m in non-line-of-sight conditions and allows wireless X-ray firing using a Golden X-ray machine. It has a lot of the boxes ticked – large X-ray area, high-quality image and long-range radio link. The use of the frequency-hopping spread spectrum is a good choice for immunity to noise and interference. Since it is not very likely that a render-safe procedure against a CBRN-IED would be taking place in the absence of radio frequency (RF) inhibition, the ability of the radio link to compete in challenging RF conditions also ticks one of the critical boxes.

Manual deployment

Positioning of an X-ray system is possible using a remotely controlled vehicle. However in the circumstances, trying to get an X-ray of a CBRN-IED, manual deployment is usually more practical and can be justified. As always a couple of old tips can make the task easier. The use of 1.5mm BB markers, as used in mammography skin markers, makes orientation

The use of the frequency-hopping spread spectrum is a good choice for immunity to noise and interference.

The PIXIUM plate in use.

of the X-ray picture more secure as well as providing a handy method of judging scale. A 10 mm-sided equilateral triangle lesion marker is another invaluable idea from the medical imaging world that assists in interpreting the picture.

One of the advantages of a digital imaging system is that the picture can be printed on plain paper with a portable printer – as well as sending it back to a higher HQ as a JPEG. Having printed it on plain paper it can be pasted on to a side of a container that looks like the target container. By manoeuvring the X-ray to get views from different directions, it is possible to build up a kind of crude 3D view by pasting each sheet on to the corresponding side of the mock-up. It is not perfect, it is very crude, but it gives the general orientation of the layout of the IED in order to plan the attack. No self-respecting IEDD kit should be without a few tubes of glue and a good choice is a one-minute epoxy applied using an auto mix system.

Intrusive versus non-intrusive?

When considering an intrusive versus a non-intrusive technology, a low-tech approach is to firmly glue the target in place to prevent excessive movement before using some kind of small cordless rotary tool to open up a spy hole, through which a fibre-optic probe could be introduced. Again there is nothing to prevent yet another plain paper printout stuck onto the target being used as a guide as to a suitable point of entry. This first hole may be a first step in a hand-dismantle technique to get an 'eye' on the target. It is also a way to get a' nose' on target and no time should be lost in getting a sniff at the contents of the container. Pre-positioning a compact CWA identifier and TIC detector near to the entry point to be made in the outer container may give the best shot of identifying a target vapour.

And to finish, back to Ernest Rutherford and the atom: Einstein once described him as "tunnelling into the very material of God". We have been set the problem of tunnelling into a more satanic material – and often do not have a great deal of choice when deciding whether to use an intrusive versus a non-intrusive technique.

Peter Daly is National CBRN Lead, Chief Emergency Management Officer, Health Service Executive, Rep. of Ireland.

Peter Daly describes the techniques in training to defeat improvised CBRN devices.

FIRST SELECT A SUITABLE IED...

The single biggest problem associated with devising render-safe procedures (RSPs) for CBRN-IEDs is the severe shortage of said IEDs. Exercises are a poor predictor of how well counter-IED strategies will work for CBRN mainly because the bomb builder and the bomb disposal specialist are one and the same person. If not, the builder has a strong bomb disposal background and as a result lacks the single-minded determination of the terrorist to build a CBRN-IED taking no notice whatsoever of bomb disposal techniques. The obvious exception is the improvised nuclear device (IND). The IND builder will have a pretty good idea of the methods used to counter such a device. Too often the CBRN-IED designer has an 'answer' or the IED is built to demonstrate the potential of some gadget or other.

The logistic burden and the consequence management of CBRN tend to obscure the procedures at the heart of an RSP for CBRN IEDs. So, the basic rule in discussing an RSP is 'first select a suitable IED'. Explosive ordnance disposal (EOD) rules don't change just because there is a CBRN element. The aim remains the same – prevent the IED from functioning as designed in order to preserve life. It is a pass or fail outcome. There are no marks for finesse. So, in my view if circumstances so dictate and it is a confirmed chem-bio IED, then countermining in place with an adequate amount of plastic explosive is a perfectly acceptable RSP. Don't try the same thing with a radiological device!

We know full well it is possible to conduct

That an RSP could be regarded as undesirable from the forensic viewpoint is but one factor that needs to be considered and it has to take its place in the queue.

operations in a CBRN environment. It's been done before from 1915 to 1918 and with a protective ensemble far less efficient than we have today. We know we can decontaminate effectively so it might be better to take those aspects as a given and move rapidly to the RSP itself. CBRN devices do not lend themselves easily to disrupter and RCV (remotely controlled vehicle – EOD robot) solutions – and in some cases conventional disruption may be the wrong answer. Of course with suitable damping such as tenting the device and filling the void with a suitable decon foam conventional disruption may work very well.

Defeating the agent

So, some form of detection is required for a CBRN IED and without dwelling too long on that phase in order to devise an RSP, it will be necessary to 'select a suitable IED'.

Consider an IED whose main design is to release a biological material. It is worth considering what kind of conditions could be created to make it difficult for the biological agent to survive. Try application of extreme heat. Few, if any, biological agents will survive proximity to a pyrotechnic torch and there won't be too much left of the IED either. It has the added advantage of being RCV-deliverable. A variation on the same theme is to consider the use of a thermite grenade or even a DIY gas torch.

Also RCV-deliverable are disinfectants such as super tropical bleach or indeed any surface and topical disinfectants, or decon enzymes. It's never too early to begin decon – even before implementing the executive action stage. Pre-deploying a few decon sprayers rather like deploying fire monitors at the scene of a fire will help reduce the impact of the functioning or partial functioning of a CBRN IED.

The same line of thinking could include deploying UV lighting as a form of disinfection. UV light between 250 nm and 270 nm is absorbed by the DNA in all living matter – or RNA in the case of a virus. The light causes cross-bonds within the DNA structure to vibrate to the point of rupture, resulting in non viability of the organism. In the case of a biological device it may well be effective, it is clear and it certainly beats doing nothing!

Bury the IED

'Sand-less' sandbags like Floodsax are a quick and effective method of creating a band round the target IED. They are absorbent and can subsequently be incinerated. They increase in weight from half a kilo to about 22 kg, so deploying them at an incident is relatively easy. As a quick improvisation it is entirely possible to bury the IED in Floodsax and then apply water to create an igloo effect. Having pre-positioned a conventional disruptive tool to target a key component, it could stabilise a situation while awaiting the arrival of more advanced disablement techniques. A further advantage can be gained by using some form of decon liquid as well as, or instead of, water.

There has been much speculation with regard to chem-bio spray devices and how effective they may be as a dispersion device. Anyone that has endured dirt in a fuel tank will know that addition of a thickening agent to the liquid will reduce or kill its effectiveness. Quick application of an even quicker-curing epoxy will limit or prevent a spray or sprinkler type device and again it can be delivered by RCV in some cases. In an instance of power then wetting of the material with a fine spray of water will reduce or eliminate the dispersion of the powder.

A prime complication affecting RSPs for CBRN-IEDs is the requirements of the forensic investigation. That an RSP could be regarded as undesirable from the forensic viewpoint is but one factor that needs to be considered and it has to take its place in the queue. But the aim of an RSP remains the same. First, select an IED and then devise an RSP that will prevent the device from functioning as designed. Simple really!

Top: CBRN-IED device adapted from life-jacket in an exercise. Peter Daly.

Middle: Using a decontamination solution in a disruptive tool. Dye is added to illustrate the way water is projected forward and balanced by the rearward action. Decon material can be used instead of water. Alford Technologies.

Bottom: Robot examines suspect in rear of a van during a CBRN-IED exercise. Peter Daly.

SOLUTIONS FOR BORDER SECURITY

Director of Borderpol's technical committee Serge Rinkel looks at the prevention of CBRN proliferation and smuggling.

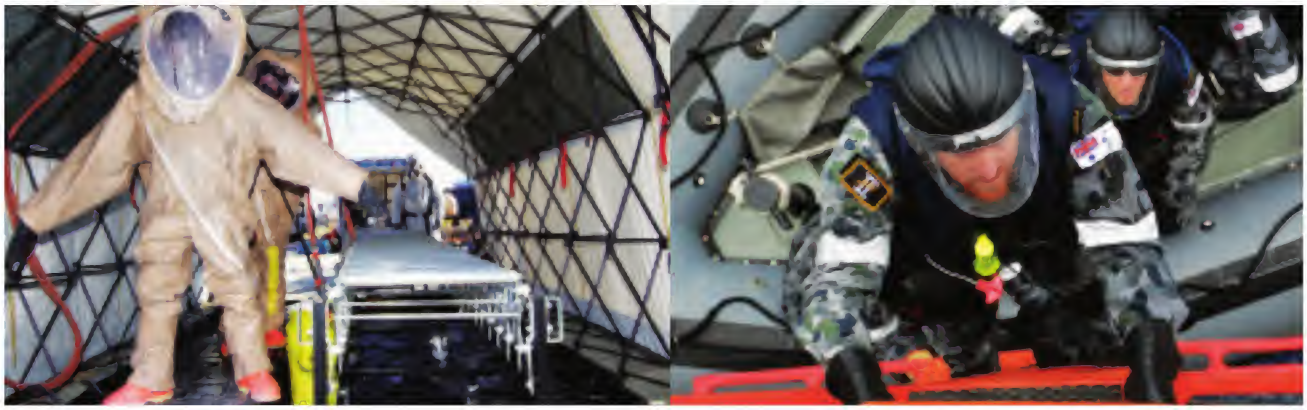
Organised crime at sea has increased considerably, benefiting greatly from the globalisation of the maritime trade with its huge exchange of goods. To bypass new international security measures, criminal syndicates constantly change and disguise their methodology, always looking for new opportunities in varying illicit markets.

There are still many available means to operate discreetly in the ocean. Gangs know how to tranship their illicit cargoes at sea and to unload them ashore for repackaging and distribution. They also know how to disguise illegal shipments within the commercial chain. Seaports and coastlines are hotbeds for criminals, smugglers, pirates and terrorists – a perfect place for 'marriages of convenience' between gangs which can easily cross land borders. These agreements between syndicates promote greater efficiency in the criminal world and enable very powerful organisations to thrive and grow, particularly where there is a lack of presence of law enforcement agencies. This laxity seems to be due mainly in the North to budget restrictions, leading to staff shortages and concentration on commercial traffic. In the south there is the additional problem of corruption, lack of motivation and equipment.

Evidentially inadequate policing attracts smugglers leading to new threats, particularly in areas concerning CBR substances. Sea-border law enforcement officers sometimes feel frustrated because they consider that enhancing maritime security and protecting seaports should be top priority. Cross-border detection of illicit dangerous goods is a crucial aspect of the maritime security challenge, because it prevents any criminal network from smuggling risky CB substances, 'dirty bombs' or genuine WMD. These maritime agencies have already detected numerous attempts to smuggle and illegally transport illicit chemical precursors or stolen radioactive sources. Most detected trafficking incidents involve opportunists or unsophisticated criminals, motivated by profit.

Lack of training

The major threat does not lie in smuggling of relatively small NBC devices but rather in the use of maritime containers which are big enough to contain any dangerous device. It is relatively simple to improve the screening of bulk or containerised cargoes by intelligence and profiling, sniffer dogs, radiation portal monitors used in conjunction with hand held radio-isotope identifiers, new radiations detectors



Left: 6th Civil Support Team under decontamination after inspecting a vessel for hazardous materials during an interdiction exercise. Right: Australian team climb aboard the Military Sealift Command fleet replenishment oiler USNS Walter S. Diehl as part of Deep Sabre II national maritime interdiction exercise, October 2009. US Navy.

STOPPING NUCLEAR TRAFFIC

John Smalling on the new generation of spectroscopic portal monitors.

The prevention of illicit nuclear trafficking in freight is vital to the international efforts to prevent nuclear terrorism. It is now well understood that commercial freight shipments can often contain innocent radioactive material which will set off alarms in non-spectroscopic radiation portal monitors (RPMs). Properly adjudicating these alarms manually is cost prohibitive.

Several seaports and border crossings are beginning to use dedicated high-resolution spectroscopic portal monitors (SPMs) for secondary inspections to determine if alarms are innocent, or if the alarms represent a true nuclear threat. These monitors allow a normal flow of commerce while still ensuring the primary goal of intercepting illicit nuclear material is met. The consequences of failing to interdict a true nuclear threat could be catastrophic.

How SPMs work

An effective SPM must rapidly identify any radioactive source present in a vehicle or cargo container. It must have adequate energy resolution ('selectivity') to quickly identify and differentiate innocent sources from illicit nuclear material. Threat sources that have been intentionally shielded or masked by innocent sources are particularly difficult to detect and identify unless the system uses high resolution detector technology.

At the heart of every RPM is the radiation detector, and in an SPM the best resolution does the best job when it comes to correct identification of nuclear threats. The 'gold standard' for spectroscopic radiation detectors is the high purity germanium (HPGe) detector. While some SPMs may still use low-resolution sodium iodide detectors, this technology is incapable of reliably identifying the radioactive contents that caused the alarm, especially with masking due to high and shifting backgrounds. Medium-resolution detectors

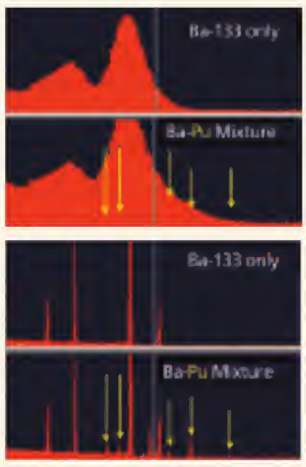


Figure 1: **Comparison of HPGe and Sodium Iodide spectra for Ba-133 and Pu-239.**

such as advanced spectroscopic portals, pH-meters, mass spectrometers, adaptive electronic sensors, and so on.

Unfortunately most of the law enforcement officers have never seen a passive detection device or dosimeter and therefore are poorly positioned to intercept those illicit and harmful substances. They face shipments passing through their sector of control without in-depth knowledge of NBC threats, without basic training and equipment to carry out their inspection activities properly. Do the border control officers and surveillance crews know that nuclear and radiation materials are transported in lead-shielded containers of various sizes, therefore requiring an inspection using a detector capable of measuring three types of ionising nuclear radiation, alpha, beta and gamma?

Carrying dosimeters should be compulsory for any inspector conducting a security examination in all border units throughout the world and high-tech radiation detectors should be used systematically at ports of entry. This potentially dangerous situation needs bespoke expert evaluation thus providing the correct equipment and training.

The role of Borderpol

How can a single state, especially when it is vulnerable, find answers to this kind of threat? It can call on richer countries for help and therefore accept some political influence. Or it can engage in co-operation with international specialised agencies such as the International Atomic Energy Agency for technical advice, or Borderpol, an international not-for-profit organisation, which is trustworthy and has no political agenda. The technical committee of Borderpol is composed of professional volunteers who intervene in foreign countries.

Borderpol develops a concept of 'intelligent border', where law enforcement officers and private sector experts work in mutual co-operation for a common goal. The issues which confront the international community with respect to global security can only be affectively resolved when open dialogue takes place among a broad group of stakeholders with input from government and industry sitting together and creating new and sustainable solutions to border security issues.

Figure 2: **Installed Detective-SPM in Anthony, New Mexico.**

such as lanthanum bromide or cadmium zinc telluride are not suitable for SPMs because of the detector size and availability and they suffer from the same masking limitations. Shown in Figure 1 is a comparison of HPGe and sodium iodide spectra for barium-133 and plutonium-239.

As can be seen, lower-resolution detectors such as sodium iodide are frequently not able to identify true threat materials if they are masked by medical, commercial or naturally occurring radioactive material sources. This problem has been solved by using high-resolution germanium technology.

Identifying radionuclides

A second key element of any spectroscopic portal monitor is the data acquisition and analysis software. The software must not only get the correct analysis results for any nuclear material present, it must also be designed to accommodate automated or semi-automated monitoring of vehicular traffic or cargo containers.

Radionuclides are identified by the presence of specific gamma ray energies in the spectra captured by the SPM. With high-resolution spectroscopic portals, the identification can be based on the sharp full-energy gamma-ray signal shown on the right side of figure 1 and not simply on gross counting. The gamma rays used for each nuclide are given in a table stored in the analysis software. The software determines when a peak is present if it exceeds a minimum threshold. This and other information are used by the software to determine whether or not the nuclide is present.

Adjustment of the specified threshold for each gamma ray in the analysis table allows the user to achieve the desired false positive and false negative rate to optimise performance. In a germanium system, the background can be determined at the same time the sample is measured by extracting the background directly from the sample measurement. Thus, HPGe-based SPMs can be much less subject to analysis errors associated with changing backgrounds.

Watching the detectives

In response to the need for high-resolution spectroscopy based portal monitors, ORTEC has developed a commercially available solution. The ORTEC Detective-SPM is designed to

"The aim's the same – prevent the IED from functioning in order to preserve life. No marks for finesse."

Figure 3: **The ORTEC Detective-SPM design is modular based on the Interchangeable Detector Module shown here.**

solve the problem of detecting shielded or masked sources by integrating high purity germanium detectors with Stirling coolers and highly sophisticated analysis software into a fully integrated SPM (see Figure 2). The highly reliable Stirling coolers simplify the deployment and safety issues associated with liquid nitrogen. The ORTEC Detective-SPM design is modular, based on the interchangeable detector module (IDM – Figure 3).

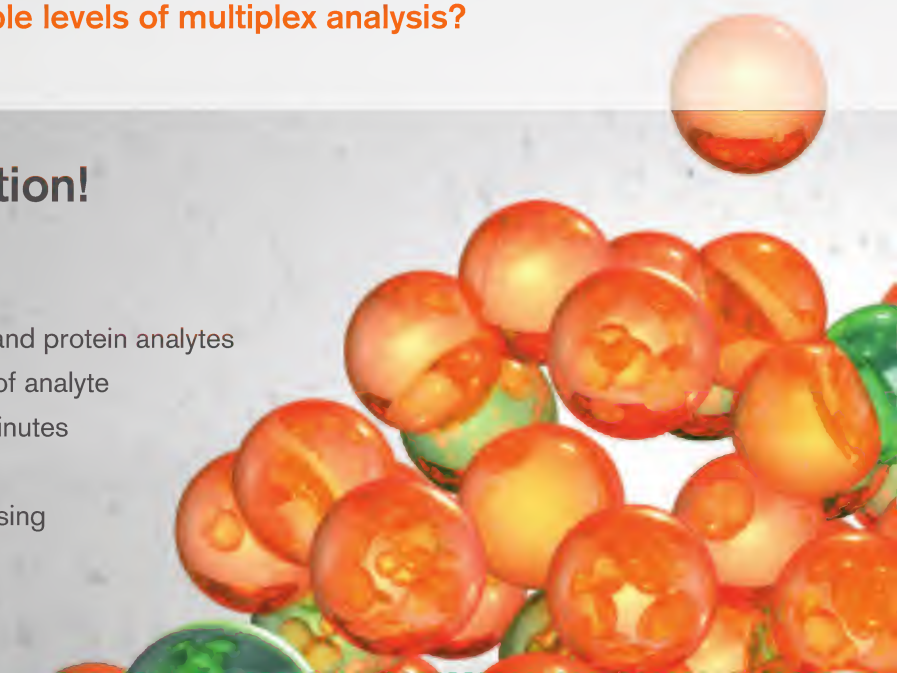
Each IDM is a fully integrated gamma spectrometry subsystem including an 85 mm diameter x 30 mm deep HPGe crystal, cooler and signal processing electronics. The integrated MCA uses the 1460 keV peak of background K-40 for gain stabilisation. The large-diameter detector is optimised for energies from 100 keV to 400 keV with sufficient response up to 3 MeV, which is the necessary energy range for detection of special nuclear material (uranium and plutonium). The Stirling cooler used in the IDM has a large reserve of cooling capacity which enhances cooler life and improves overall system performance.

The state of health of each IDM and the system is always known and monitored. In the unlikely event of an IDM failure the system continues to operate at a slightly reduced capacity and the operator is alerted to the fact that the IDM is not operational. The IDM is designed as a plug-and-play device requiring a single power and computer connection. Replacement can be completed quickly.

A detective-SPM with eight IDMs is sufficient to meet the identification requirements prescribed by the applicable standard ANSI N42.38. These systems are scalable to meet other performance needs and may be configured for applications from package to rail monitors. The ORTEC portal utilises a NEMA 4 cabinet and is designed to operate at temperatures from -40 C to 55 C and with humidity up to 100 per cent.

Both the ORTEC IDM and the ORTEC spectroscopic portal analysis software are now proven products. A turnkey detective-SPM was installed in Anthony, New Mexico, USA in 2009. Other systems were built for test and evaluation since 2006. The New Mexico system has operated without failure for over 14 months. The system can be equipped with optional neutron detection capability and is also easily expandable by virtue of its modular construction. Should neutron detection or greater gamma sensitivity be required in the future, they may be added to an installed system.

John Smalling is Director of Homeland Security, Defense & Energy Programs for ORTEC. He works with several agencies to provide technologies to prevent illicit nuclear trafficking.



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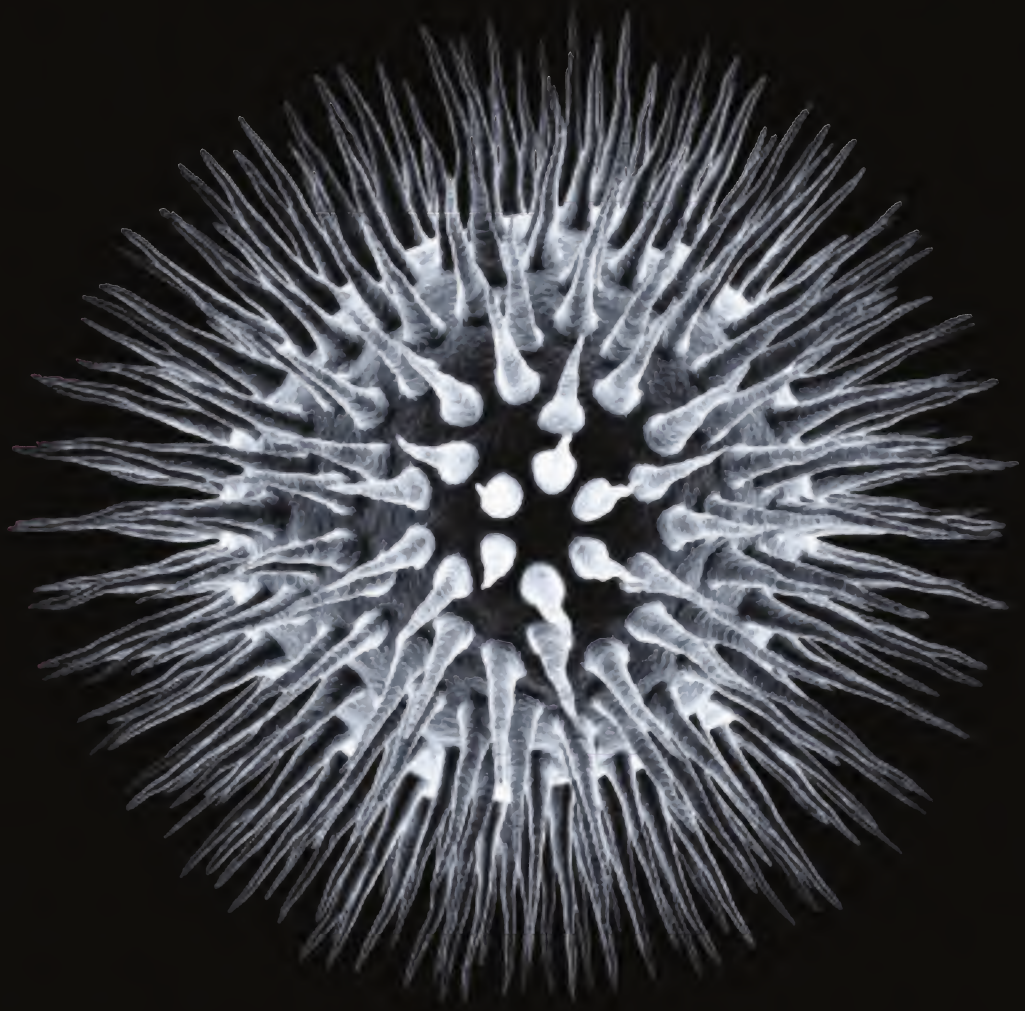
BIOLOGICAL DETECTION FOR SENTINEL SYSTEMS



Biodetection presents a diverse and multi-faceted threat. Paul Gascoine, Principal Biotechnologist at Smiths Detection, assesses the latest advances in mobile and fixed systems for sampling, testing and identification of pathogens – and how to avoid false alarms in microbe-rich environments.

The range of targets covers bacteria and viruses which can reproduce given the right circumstances along with toxins, which do not and can be considered a subset of chemical threats. Among these three classes exists an enormous range of pathogenic organisms and toxins, evolved to be efficient in their biochemical action, while remaining difficult to detect.

Biodetection differs from chemical agent detection in that for most cases, once exposed to the threat, the victim takes some time to exhibit symptoms. Toxins in high concentrations have an immediate effect on the body, but in low doses even these can be difficult to diagnose. Ideally the target would be 'detect to warn' to identify the threat in advance but with current technology it is still 'detect to treat' whereby the threat has to be determined after the event.

Despite all this diversity of targets, biodetection systems need to unerringly identify the small concentration of dangerous target in a typically mixed sample of other matter, while avoiding false alarms due to similar, harmless species. The supply and provision of specific antibodies or synthetic ligands against these threats is an enormous area of endeavour that can only be touched on here. The most important element in any identification chain is the antibodies or ligands that confer the selectivity. Without their involvement, systems could be sensitive, but not selective.

The detection of a pathogenic species then prompts the next question; was it deliberately released or is it a natural occurrence? In many parts of the world, for example eastern Turkey, infectious diseases commonly on the 'threat list' can break out as part of their natural cycle. Determining their origin is an ongoing scientific detective task.

Typical detection systems use air sampling, concentrating the aerosol into a liquid medium, more amenable to sensitive assay. The endless variation of the 'general background' which contains diesel particles, pollen grains and a large variety of other substances can all interfere with the determination. In public spaces all manner of unusual molecules are present, many of which can interfere with carefully designed biological test systems.

Current biodetection problem areas

Although scientific progress focuses on the final 'identification' element of the detection chain, there are several key components. System performance is a result of all the elements combined. Even state-of-the-art equipment does not function well in the presence of very dilute, poorly prepared samples. Sample collection, of whatever type, is an important stage, along with any preliminary clean-up. This can be complicated since there are often a number of different technologies in use, all of which require different treatments. Until recently sample preparation was something of a Cinderella science, but the realisation of its importance in the detection chain has renewed interest in the area.

For practical and ease-of-use reasons, lateral flow assays (LFAs) tend to be used for toxin testing, whilst polymerase chain reaction (PCR) is the current favourite for bacterial and viral detection. Both benefit from clean samples, but PCR especially requires cells to be broken open to release their DNA and remove the molecules that inhibit the reaction,

Left: Typical lateral flow assay (shows positive for ricin and botulinum toxin). Right: Sentinel system for outdoor events

causing false negatives – that is, registering the threat is not present when in fact it is. For reference LFAs tend to suffer from a different malaise, namely false positives, whereby the test shows a positive result but the target is absent.

One key aspect, which is different from many other areas of biological testing such as diagnostics, is that biodetection equipment will often be operated by non-specialists. This requires the instruments to give unambiguous yes/no answers and be easy to operate. Ruggedness under harsh conditions are a given for these devices, as is the fact that at some point, their performance has been proven against the designated live agents within a suitable containment suite. A final area of concern is decontamination; what to do when a positive hit is confirmed? Some instruments are 'fully submersible' in bleach, while others are more sensitive. This area currently is still under debate.

Mobile systems

Mobile systems, for public places and large-scale events

Decon Shuttle

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Above: Testing field-based PCR system with the Smiths Bioseeq. Right: Analysing a suspect powder with raman spectroscopy.

such as the Olympics, need to be discrete and self-contained. Ideally they should be operating almost invisibly, hidden in street furniture. However, at the present time mobile systems are mainly vehicle based. The benefits of this approach are that they do not need to operate continuously for long periods and can provide for data analysis and encrypted communications capabilities, all in a protected environment.

In order to provide a confident result, it is often preferable to employ a tiered system of analysis. In this way false alarms are avoided and so called 'orthogonal' technologies are employed, for example if both PCR and LFAs give the same result, there is a greater likelihood of a real positive. Typically a system will have, as a first layer, a particle analysis device based on some form of laser scattering to continuously assess the background and report any changes. These devices respond in a few seconds. Multiple wavelengths can give more information, for example absorbance at particular wavelengths can be indicative of protein or DNA, while reducing false alarms. Also, recent developments in algorithm evolution and the ability to 'learn' a particular environment can all improve performance. Alternatively, if the vehicle is driven round the route or area prior to the real event, anomalous effects can be encountered and dealt with in advance, for example canteen outlets or fumes from cleaning materials.

If the preliminary analysis is positive, a liquid aerosol sample is then generated which is used to identify any BW agents via PCR or LFA. However, these results can take 60-90 minutes to achieve, especially if there is some sample preparation required, or if positive tests are re-run to confirm the result. Normally the presence of a positive result means a presumptive identification can be made and operations adjusted accordingly. However a sample is always required for 'gold-standard' analysis at a government-approved laboratory, often using standard microbiology to grow up the organism and identify it from first principles. This can take several days, which is the benefit of a well-designed mobile sentinel system – which in the one- to two-hour detection window can give advance warning of a biothreat event, whether natural or as a result of human intervention.

Sentinel systems for buildings

Buildings-based systems are more problematic than mobile ones, and are best incorporated at the design stage, fully integrated into the air conditioning and communication networks. These 'smart buildings' are only just coming into being and most building BW sentinel networks are retrofitted into established high-value locations. The advantages of a 'built-in' system are manifold. Communications can be handled from a central location, algorithms can make the best use of the sensor network and the hardware itself can be best positioned for maximum coverage and ease of maintenance.

"The endless variation of the 'general background' which contains diesel particles, pollen grains and a large variety of other substances can all interfere with the determination."

From the BW point of view for in-situ systems, the problem comes from the continuous running, in terms of cost and regular replenishment with bioconsumables. Apart from the laser particle analyser, which requires very little attention, most other BW detection equipment needs some manual intervention or at least replacement liquids. In addition there is the requirement for bulk storage of bioconsumables, which still generally need 2-8°C conditions or at least room temperature (18°-22°C) to maintain their efficacy. All this cost and complexity means that ongoing building sentinel systems for biodetection are very unusual and reserved for the most precious assets.

ALPHA THE FINAL FRONTIER IN RADIOLOGICAL DETECTION

Typical alpha detection must be done close to the source and intensive measurements made manually, particularly of large items.

Senior technical consultant for Babcock Nuclear Kevin Whitehouse hunts down the elusive particles.

Of all of the possible contaminants likely to be discovered after a radiological incident, either caused by accident or a terrorist event, pure alpha particle-emitting radionuclides can be considered to be of prime concern. This is due to the high biological damage that can be caused should such alpha contamination be brought into the human body via ingestion, inhalation or entry through wounds (as demonstrated in the Litvinenko assassination) and the challenges in detecting and measuring alpha contamination.

Alpha-emitting sources are difficult to detect due to the short range of the particles in the air, typically requiring specialised detectors to be presented within a few tens of millimetres of the contaminants. Where the alpha contamination is absorbed within porous materials or covered by paint, water film or other material (including a sheet of paper) the alpha particles are not capable of being detected. This hidden contamination is then released once the material is disturbed or dries out.

The design of typical alpha detectors requires the alpha particle to penetrate into the measurement volume, requiring extremely thin windows that are easily damaged potentially destroying the detector. These requirements for close proximity to the source yet protection of sensitive detectors from damage are often mutually exclusive, particularly in the uncontrolled conditions in the aftermath of an accident or incident.

Where contamination is present inside objects, pipes, etc the alpha particle is not able to escape out of the item and thereby is unable to be detected. This leads to two situations; one, where the item is monitored and 'found' to be clean and two, where the item is always assumed to be contaminated internally.

To overcome some of these obstacles a number of potential 'stand-off' techniques have been investigated relying on the detection of the effects of alpha particles

passing through the air or other medium. Two techniques currently available rely upon the ionisation of air molecules caused by the alpha particles as they travel through the air.

Optical fluorescence

One technique under investigation, by the University of Tampere in Finland, relies upon the ultra-violet fluorescence of air molecules induced by the ionising radiation. It has been shown that this ultra-violet emission can be detected at a distance of up to 30 cm, even through plexi-glass windows of a glovebox. The system uses either photomultiplier tubes or charge coupled device cameras to detect the UV emission from fluorescing nitrogen molecules.

While results have been promising and the technique is reported to have detected a 1 kilobecquerel alpha-emitting source from a distance of 40 cm, there remains the challenge of discriminating the weak fluorescence signal from the ambient lighting conditions. This technique has resulted in a portable demonstration device that looks to be promising for safety and security applications where fast remote scanning of alpha radiation is required, especially if issues with ambient light conditions can be addressed.

Long-range alpha detection

The second technique, developed by Babcock Nuclear Ltd in collaboration with Los Alamos National Laboratory, measures the ionisation in the air itself. In most gases, including air, an energy of approximately 35eV is required to produce an electron-ion pair and therefore a typical 5MeV alpha particle will produce around 150,000 ion pairs. These ion pairs last for several seconds, sufficient time for them to be transported over a range of several metres to a point where they can be detected.

The ions are attracted to a grid electrode by an electrostatic field or via a fan-generated airflow. At the electrode the ions cause a small electrical current to flow through the detector circuits which is directly proportional to the alpha activity of the item. This technique is particularly suited to measuring the alpha contamination on the outer and inner surfaces of pipework and large items. If air can be directed over the area of interest the system is able to detect the ionisation produced by the alpha source.

One application that has been employed within the UK nuclear industry has been for the detection of alpha contamination on scaffold pipes. The large-scale maintenance and decommissioning programmes currently ongoing within nuclear facilities gives rise to large amounts of pipework, ducting, scaffold poles and so on that cannot conventionally be declared as clean due to the potential for internal contamination or the costs associated with manually swabbing the inner and outer surface of large quantities of such materials.

This pipe monitor comprises three main components: a detector unit, an input unit and a measurement module. Air is drawn into the input unit using a fan and ion filter. As the air enters the system it passes through the ion filter where dust and ions are removed. This air is then passed through the measurement module where it is drawn over both the internal and external surfaces of the pipe and becomes ionised by any alpha contamination present. The ionised air is then drawn into the detector unit where it passes over a parallel plate electrostatic detector causing a small electrical current to flow. The spent air from the system is exhausted through an HEPA filter (to ensure that any loose contamination is prevented from being released to atmosphere).

This technique has been demonstrated using small 'open' alpha sources varying from tens of Bq (Becquerel) to hundreds of Bq and has proven to be a sensitive, efficient and reliable method of measuring the amount of alpha contamination on both the inside and outside of pipework and other large items. The system is capable of demonstrating that such items are below the UK free-release limit of 0.4Bq/sq cm alpha contamination. The technique appears ideally suited to use during recovery operations following clean-up after an accident or incident where it becomes necessary to ensure that items are accurately assessed as clean or contaminated.

In most gases, including air, an energy of approximately 35eV is required to produce an electron-ion pair.

While alpha contamination remains an area of concern for conventional measurements, these two novel approaches may provide rapid, cost-effective, remote stand-off detection of alpha contamination.

Kevin Whitehouse C.Phys, C.Eng, M.Inst.P has 25 years experience in the measurement of nuclear materials in the UK nuclear and defence sectors.

The Babcock IonSens system permits alpha contamination to be detected inside pipework and other large items.

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NEXT-GENERATION DIAGNOSTICS

Whereas exposure to most chemical warfare agents would have an immediate and rather dramatic effect, exposure to biological threat agents in the form of powders or aerosols may occur with a scarcely observable subtlety. Lt Col J F Koterski, and Captain O D Hottenstein, examine advantages of microassays for biological testing.

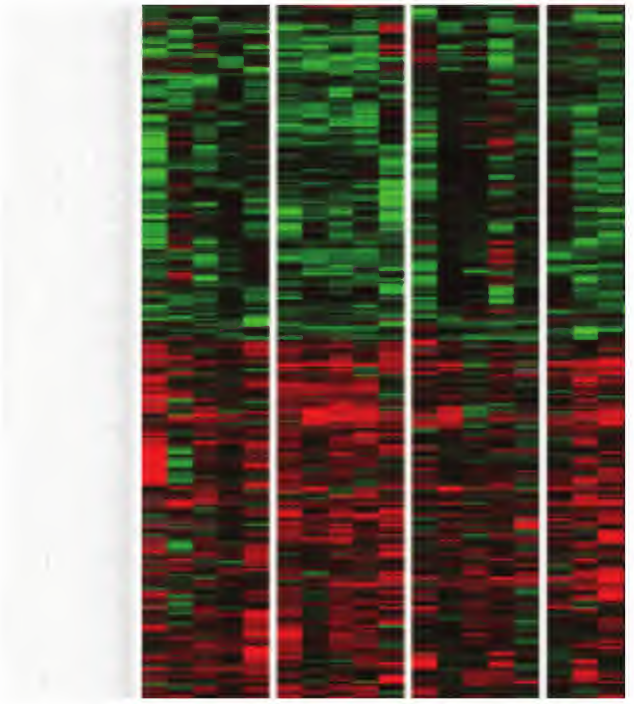
While exposure to most chemical warfare agents would have an immediate and rather dramatic effect, exposure to biological threat agents in the form of powders or aerosols may occur with a scarcely observable subtlety. Detection of the presence of biological threat agents may focus on environmental samples (most commonly air or water) or patient samples (commonly blood or fluids). Diagnostic testing for infectious disease has been classically based on detection of the agent itself (nucleic acids or exposed antigens) or to test the host for the presence of immunoglobulin (antibodies) specific for a particular organism or component thereof (virus or bacteria).

Florid symptomology in a patient due to biological agent exposure would likely occur only after an incubation period of several days. The period between exposure and illness represents a critical window of opportunity for medical intervention: "Time is but the stream I go a-fishing in" (Henry David Thoreau). One of the problems with the traditional culture methods and antibody titering in virology and bacteriology is that you have to know what you are fishing for, as you pretty much test for agents individually. Another issue is the fact that military operations are frequently conducted in austere environments, where laboratory facilities may be rudimentary or non-existent.

Enter the microarray

A new approach is to examine a wider spectrum of the host response. In theory, a specific agent should elicit a specific constellation of gene expression activities that may be characterised as a signature for that agent. The microarray is one method for assessing the activity level of a very large number of genes at once. Microarray studies in infectious diseases usually focus on the white blood cells in circulation. In effect, it's like a group portrait of your immune system, showing what they are collectively up to at a given moment in time.

In theory, microarray portraits of gene expression or protein production could provide us with the medical intelligence, tell us what cells are saying and doing in response to invasion, and clue us in to the nature of the invader early on. The biggest challenge presented by microarray technology is the volume of information. Most assays contain tens of thousands of genes. The trick will be to figure out what is truly significant and portentous of pre-symptomatic bio-illnesses. Finally, packaging the instrumentation into portable, ruggedised versions for international use will provide effective diagnostic tools.



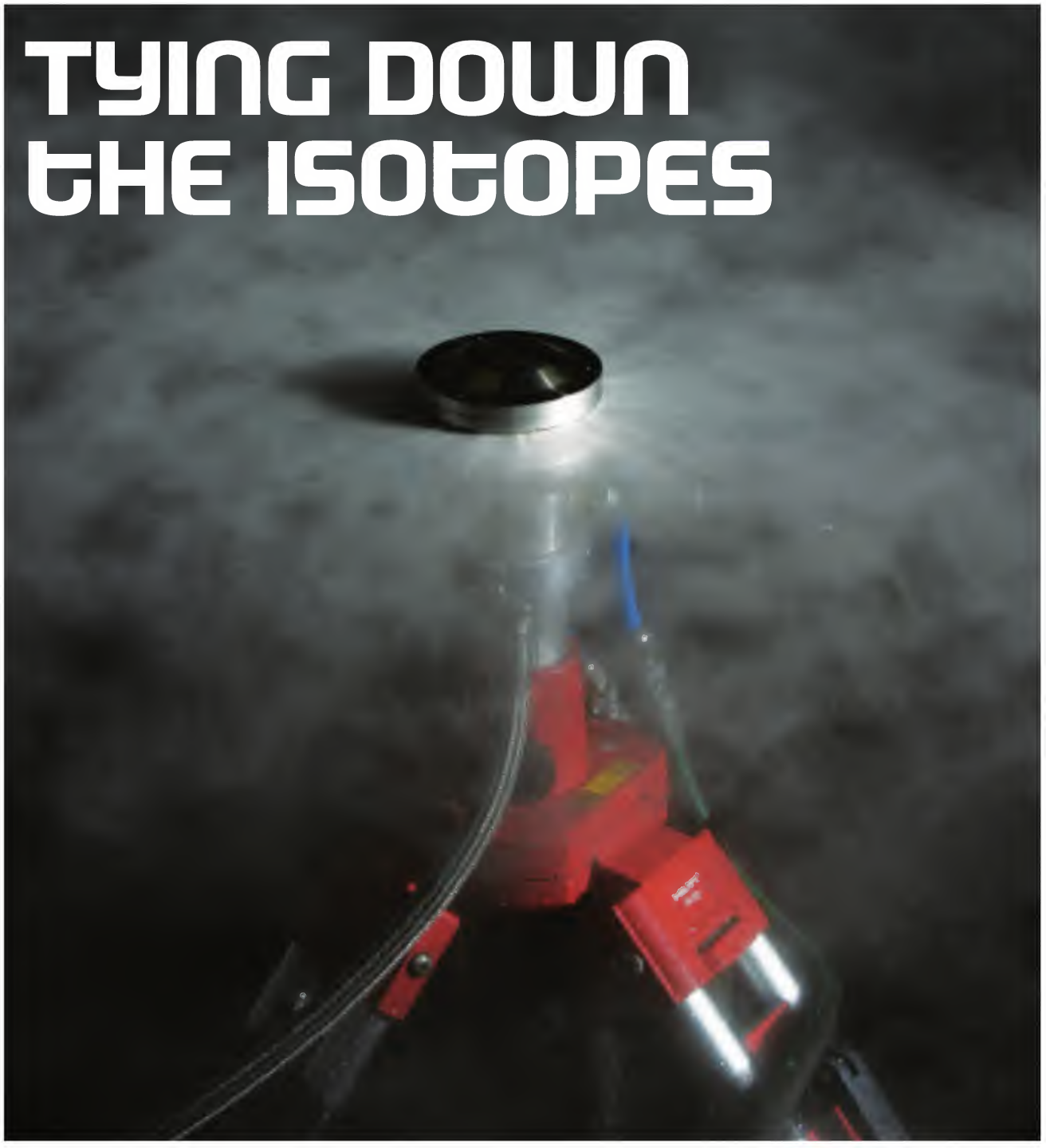
Typical microarray display depicting changes in gene expression.

Austere environments require ruggedised new diagnostic approaches.

The biggest challenge presented by microarray technology is the sheeer volume of information.

LTC Koterski is a veterinary microbiologist with a DVM from Louisiana State University, a PhD from Rutgers and is also board certified in veterinary preventive medicine. Dr. O. D. Hottenstein is a public health service officer who received his doctorate from the School of Hygiene and Public Health at the Johns Hopkins University in Baltimore, Maryland, USA.

TYING DOWN THE ISOTOPES

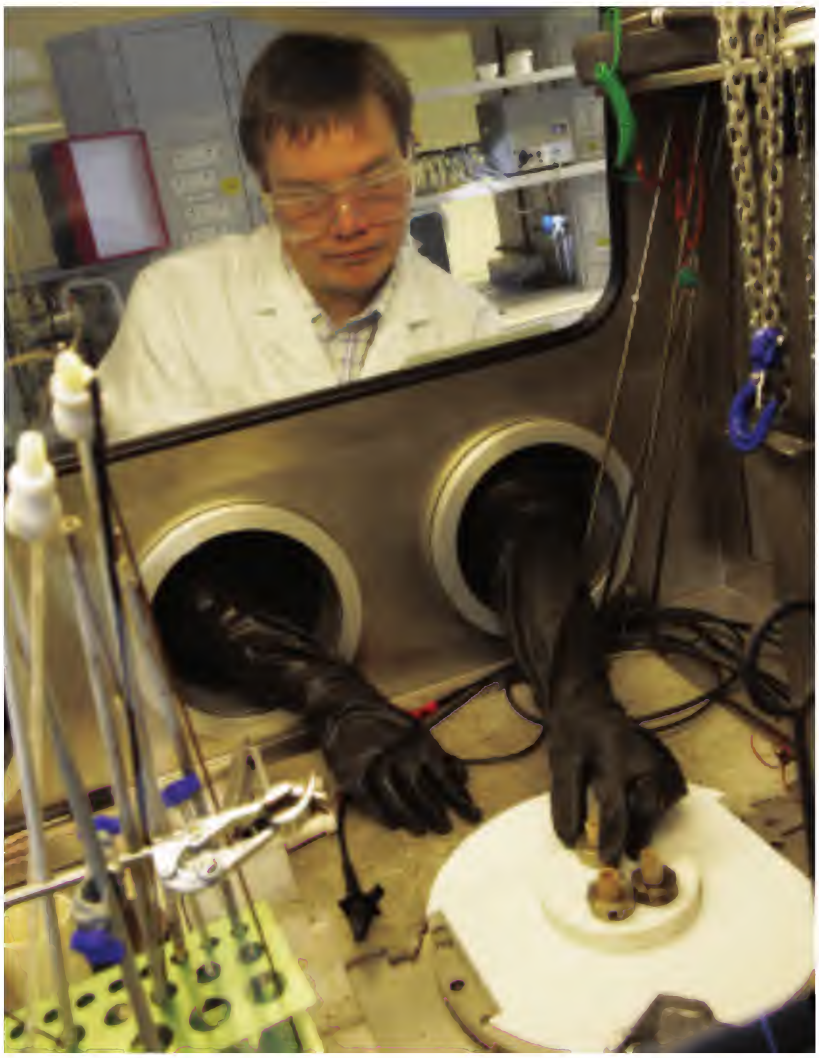


Dr David Crouch of PDX looks at current trends in radiological decontamination

Radioactive contamination of buildings and other urban places can present substantial health and environmental hazards, and the development of materials and processes that can be used to sequester such contaminants is an essential part of any strategy for the remediation of contaminated sites. People can be exposed to significant radiation levels, externally and internally, from the spread of contamination following an accident (or a deliberate initiation), in some cases involving significant quantities of radioactive material. The Chernobyl nuclear accident in 1986, for example, exposed more than 100,000 people to high levels of radiation, rendering hundred of acres of land across Europe infertile.

Present strategies for alleviating radioactive contamination involve either demolishing and removing radioactive contaminated infrastructure or abandoning portions of the area near the release point. In both cases, it is imperative to eliminate or reduce migration of the radioisotopes until the cleanup is complete or until the radiation has decayed back to acceptable levels – that is, dose rates below the supervised area definition.

The technical obstacles to such remediation are, however, severe since unlike chemical and biological threats, radiological hazards cannot be destroyed. They can merely be isolated or removed. The half life of any contaminating isotope may run into tens of hundreds years rendering a building isolation strategy impractical (e.g. Pu-239 is a



Protection of nuclear workers is paramount: glove boxes are used here.

staggering 24,200 years). The contaminating isotope may be present in very low concentrations and still present a hazard. For example, the Russian dissident Alexander Litvinenko was poisoned with only 10 micrograms (10 millionths of gram) of radioactive Polonium-210.

Contamination is forever

Po-210 emits essentially only alpha particles that will not penetrate a sheet of paper or the epidermis of human skin, thus making them very difficult to detect using standard first-responder sensor radiation systems. Unlike gamma-ray-emitting substances, which can be defeated to some extent with distance shielding, short-range hazards such as alpha- and beta-emitting substances can only cause significant damage if digested or inhaled, acting on living cells like a short-range weapon. Although the Litvinenko murder represented an ominous landmark – and the possible dawn of an era of nuclear terrorism – it also highlighted the very real dangers presented in failing to adequately decontaminate surfaces following a radiological release.

Whilst thousands of radioactive isotopes exist (~2,800), only a few, all produced in nuclear reactors, are of concern from a non-state actor point of view. The most probable and dangerous radionuclides that could be obtained in any useable quantity are Cesium-134 and Cesium-137, Strontium-90, Cobalt-60 and Americium-241. Comprising of mainly alpha- and beta-emitting substances, this list illustrates that any effective decontamination scheme must have, as an integral part, a plan for surface passivation and the delivery of fixatives to effect the tie-down (fixing) of airborne particulate contamination, to prevent inhalation or ingestion of these potent short-range hazards.

Total flooding to strippable coatings

The current approach to decontaminating radioactive surfaces involves 'total flooding' using large quantities of active effluent that then requires subsequent treatment and this is highly inefficient in terms of cost. Strippable or temporary coatings are innovative technologies for surface decontamination that effectively reduce loose contamination at relatively low cost. Composing of blends of polymers, copolymers and additives that can be brushed or sprayed onto a surface as a solution or dispersion in aqueous media, the effectiveness of strippable coatings has been demonstrated at several nuclear facilities, including Los Alamos National Laboratory and Savannah River Site. Strippable coatings were also used at the nuclear accident sites in Chernobyl and Three Mile Island.

The process by which strippable coatings remove contaminants from a surface is simple. As the coatings dry, the contaminants are drawn and fixed into the coating matrix. Subsequent removal of the coating with entrapped contaminants results in some degree of surface decontamination. Although strippable coatings have demonstrated some success, their development is still in its infancy, and there are still many problems and limitations associated with their use. For instance, the high viscosity of many of these materials means that they still require inefficient brushing or spraying by an exposed worker inside the contamination zone to afford decontamination. Ideally remote operation and delivery is needed in any radiologically contaminated environment.

One alternative technology currently under development is the use of 'dual fluid' atomisation nozzles to afford delivery of the temporary coatings. Dual fluid atomisation systems, which use a gas to atomise a liquid, are the only successful systems for producing a large dense cloud of very small droplets, especially from highly viscous liquids. Capable of reaching non-line-of-sight surfaces, and with no moving parts, dual fluid systems can deliver strippable coatings with improved film formation and cure rates, further reducing the effluent footprint by providing efficient tie-down of the radioactive material. Effective against airborne and surface threats, capable of knock-down of short-range particulate hazards and the isolation of highly mobile species such as Strontium-90, Cesium-137 etc, such innovative systems offer fully remote non-human decontamination of radiological contaminated sites.

Dealing with external exposure

If direct human exposure to radiological contamination is inevitable or can be predicted, then several decontamination options are available: For external exposure to radioactive contamination the biological effects are generally the same as those from an external radiation source not involving radioactive materials, such as X-ray machines, and are dependent on the absorbed dose.

In these cases decontamination can be provided simply by removal of outer clothing and rapid washing of exposed skin and hair removing ~95 per cent of contamination. A 0.5 per cent hypochlorite solution similar to that used for chemical agents will also remove radiological contaminants. However care must be taken to not irritate the skin. If the skin becomes erythematous (with dilated and congested capillaries), some radionuclides can be absorbed directly through the skin.

The biological effects of internally deposited radionuclides depend greatly on the activity and the biodistribution and removal rates of the radionuclide, which in turn depends on its chemical form. Biological effects may also depend on the chemical toxicity of the deposited material, independent of its radioactivity. Nonetheless treatment of suspected internal contamination should be undertaken as early as possible so reducing the absorbed radiation dose and the risk of future biological effects. As the onset of symptoms normally requires days to weeks there typically will be no characteristic signatures. Radiological materials are not recognisable by the senses, and are colourless and odourless.

The current approach to decontaminating radioactive surfaces involves 'total flooding'.

...and internal contamination

Recent advancements in internal radiological decontamination include the development of 'blocking' and 'chelating' agents. Potassium iodide prophylaxis, for example, works prior to exposure by saturating the thyroid gland, blocking the uptake of widely available Iodine-131. Mobilising agents conversely can be given post-exposure to expedite the excretion of specific contaminants. Propylthiouracil or methimazole may be given to reduce the thyroid's retention of radioiodine. Ingestion of the RDD candidate material Cesium-137 can be treated with the chemical Prussian blue, to accelerate fecal excretion of this isotope.

Diethylene triamine pentaacetic acid, another chelating agent, is intended for effective removal of multivalent radionuclides such as plutonium or americium. Radical scavengers such as Amifostine offer a broader spectrum chemical approach to internal decontamination by 'mopping up' free radicals caused by radiation, reducing cell mutation and possible cancer. While the development of such chemicals can be effective in reducing doses from intakes of radiological contaminants, they should not replace other countermeasures that aim to prevent or limit human exposure to radiological contamination in the first instance.

Dr David Crouch is Principal Scientist (Decontamination Sciences) at PDX.

PREVENTION PROTECTION RESPONSE RECOVERY

US Nuclear Counter-Proliferation Officer Maj. Darrin Smith examines the role of military support for the first-responder community.

Disasters come in many shapes and sizes. Whether natural, man-made or terrorism-related, all have the potential to overwhelm the response capabilities of local first responders. The terrorist attacks of 9/11 in the United States changed the way that governments respond to and view catastrophic incidents. Response procedures were further changed by events such as Hurricane Katrina and the Haiti earthquake. The value of military assistance to responders was immensely recognised while these areas were still reeling from large-scale disasters involving great psychological, economic and social impact.

The military of a country is recognised for its war-fighting ability and the responsibility of the security of its citizens. As terrorist attacks have expanded and become more complex, the military has found itself fulfilling a traditional role of a first responder. This mission has continued to expand to encompass the full spectrum of activities necessary to prevent, protect, respond and recover from a disaster. National security has become a shared responsibility that now falls on the first-responder community as well as military forces. This responsibility has adapted to address the entire range of threats and hazards to include those of CBRNE and WMD.

The US government has issued homeland security Presidential Directives that establish policies and procedures necessary to support its vision and goals for defending the homeland. Within this framework, a capabilities-based planning process identifies a target capabilities list that is integral to national-level, all-hazards preparedness. This supports the National Response Framework and National Incident Management System utilised by incident commanders and responders. It also helps to identify, prioritise and protect critical infrastructure and key resources necessary for the sustainability of the citizens. It is here that the military engages its wide range of resources in an assistance role of domestic security.

Prevention

With prevention, the military has assumed an important role across the globe. This role has been primarily focused

Left: CST member passes through the Atlanta Fire Department decon unit. Middle: Georgia State Patrol SWAT team conducts SCBA familiarisation with the military. Right: CST boards a C-130 with a scaleable package to fly in and support first responders.

on intelligence operations gained in direct action and operations designed to deter would-be adversaries from pursuing attacks. The military has continued to conduct site-sensitive exploitation operations abroad to determine the latest emerging threats and trends. This information is shared with partner countries and then passed into the public safety channels to direct and focus training efforts.

These efforts are showcased with intense training programmes at locations such as the Defence Research and Development Canada programme at Suffield in Canada, where the Counter Terrorism Technology Centre trains first responders on chemical and biological incidents and assists with the development of guidelines on response. Exercise programmes such as the US Army Reserve Red Dragon series tests the ability of the military to conduct defence support to civil authorities operations responding to a large-scale CBRN disaster – while integrating civilian law enforcement, fire services and hospital personnel.

Protection

Protective actions help to reduce the vulnerability of recognised critical infrastructure and key resources from terrorist attacks, major disasters and other emergencies. Military forces embrace risk management and systematic planning when conducting any operation. This has helped local responders refine their ability to define associated risk with protecting key resources in their jurisdiction and implement best practices.

This collaboration often extends into the private sector where business resiliency is a must for continuity of operations. Programmes such as the US DHS Prevention and Response to Suicide Bombings course teach the necessary steps of conducting vulnerability analysis and implementing effective countermeasures. Military and civilian instructors share the responsibility of delivering the course to first responders; practical exercises showcase the devastating effects of the detonation of various explosives currently available to terrorist organisations.

Response

Response activities address the short-term direct effects of an incident. Here immediate actions are taken to save lives, conserve property and stabilise the incident. This is where first-responder resources can quickly become overwhelmed and the activation and effective timed response of the military is critical to both the public and private sectors. Military forces possess very technical resources that are not always available within the first-responder community. US assets such as a Homeland Response Force bring mass decontamination, mass casualty, search and extraction, and enhanced security capabilities to an incident commander and can typically fulfil the role in the six-to-72 hour mark of an incident. Military forces are also tailored to conduct detailed chemical detection, biological sampling and radiological surveys. Military units have also been used in emergencies such as the 2009 Victoria brushfires in Australia and the UK uses explosive ordnance disposal and rescue assets to assist civil authorities.

Recovery

Recovery missions utilise logistics and engineer the forces to augment first responders. Missions can include restoration of necessary infrastructure such as pipelines, bridges, and telecommunications. They may also include long-term environmental sampling missions such as those ongoing in the Gulf of Mexico, and radiological surveys of potentially contaminated areas as seen in the Litvinenko polonium-210 poisoning case. Recovery assistance is an especially important role as mitigation is necessary in the restoration of services to pre-disaster conditions. The first-responder community typically lacks the resources and funding necessary for long-term recovery operations.

Catastrophic events will always carry tremendous significance because of the potential for casualties, damage and disruption. First responders will have to prioritise resources towards these events. Effective pre-planning and training with military forces will aid in responding to and mitigating disasters and enhance recovery efforts. Mutual aid agreements and multi-jurisdictional collaboration between first responders and military forces will shape an all-hazards approach to preparedness. This will pair military and civilian forces for future disasters, whatever they may be. Time will tell how well these efforts work.

Maj. Darrin Smith has ten years' experience in military support to civil authorities. He has held multiple assignments with a US WMD-Civil Support Team and is a member of the International Association of Emergency Managers.

CST provides communications support to the Georgia Search and Rescue Team on a joint exercise.

LEARNING FROM LITVINENKO

Matt Tuck, Managing Director of Matom Ltd, describes lessons learned from civilian incidents for radiological protection and response.

Left: Radiological survey of Litvinenko's study. Right: Day-to-day job of health physics in a high-level radiation area.

To examine progress in response and recovery operations for CBRN incidents, our attention must turn to the highest-profile incident in recent years in the UK: the murder of Alexander Litvinenko in 2006 using a radioactive isotope. To better understand what has been learned from expert contractors involved in this incident and applying it in the future, we must reflect on the nature of the expert contractor skill base.

Keeping radiological materials safe

Radioactive material is widely used throughout industries within the UK, as in most developed countries in the world – in civil nuclear power, pharmaceuticals, oil and gas exploration and exploitation, civil and structural engineering, and education. These are extremely controlled environments that have legislatively-guided procedures for operation of facilities to minimise the risk to operators, the public and the environment.

Radiological protection (health physics) is the specialist area that provides the safety input to operate plant and facilities using radioactive materials. More specifically, health physics is the area of environmental health engineering that deals with the protection of the individual and population groups against the harmful effects of ionising and non-ionising radiations.

The health physics community in the UK is particularly interactive, at professional and operational levels. Expert contractors with health physics services have procedures that are closely aligned, among themselves and also the nuclear-licensed sites (e.g. nuclear power plants, pharmaceutical manufacturing, submarine bases). Nuclear-licensed sites have sets of conditions with which they have to comply. This is achieved through a cascade of procedures from management control through to operations, maintenance, decommissioning, waste management etc. Contract organisations with speciality skills in the nuclear industry (health physics services for example) work to exacting standards as a matter of course.

Response and recovery: Litvinenko 2006

The Litvinenko example was an extremely focused, personalised attack which by its nature (radiotoxic poisoning) is almost impossible to respond to in the manner of a response to a dirty bomb (radioactive material plus explosive device) where there is an extremely physical action associated with the use of radioactive material, i.e. an explosion, giving unprecedented notice.

More significantly perhaps, this type of attack – more akin to a bioterrorist attack – is very difficult to protect against without installing monitoring systems at entry/exit points similar to walk-through metal detectors. These systems of control are standard on UK nuclear-licensed sites, but are expensive and intrusive, both physically and psychologically, so unlikely to be an option for private sector, or more specifically service industry, protection.

Westminster City Council (WCC) assumed control over the recovery stage of the Litvinenko incident for nine of the worst contaminated sites. WCC were supported by several advisors, which included the Government Decontamination Service (GDS – a section of DEFRA) and the Health Protection Agency. The role of GDS is recovery from deliberate and accidental releases of CBRN materials and from major accidental releases of HAZMAT. Once an event has an operational requirement, GDS calls upon its framework of specialist suppliers to assist in the decontamination and cleanup works.

The dispersal of the radioactive isotope Polonium-210 (Po-210) necessitated services from the framework radiological protection and health physics specialists. For specialist suppliers such as Matom, Po-210 is a simple isotope to work with in a contamination environment as it is not particularly mobile, can be easily protected against with appropriate PPE, and does not pose an external radiation hazard. The other simple advantage of dealing with radiological as opposed to chemical and biological hazards is that they can be monitored with relative ease in real time.

Extent of contamination

A number of premises were contaminated in this attack, mostly through cross-contamination by the movement of different individuals. Matom was contracted for the recovery

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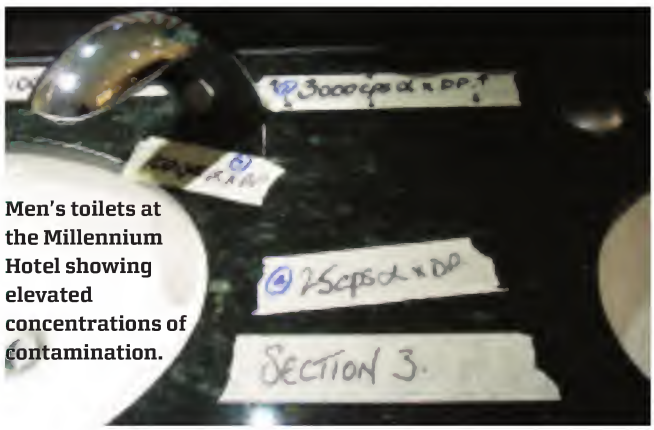
of the Millennium Hotel and the Litvinenko family house in London. The Millennium Hotel had contamination spread throughout the Pine Bar and men's toilets on the ground floor and three guest bedrooms on the first floor. Within the Pine Bar the radioactive contamination was quite extensively, and included the staff side of the bar. Similarly in the toilets the washbasins, marble worktop and a urinal were contaminated. In the bedrooms, the contamination was spread throughout, including the en-suite bathrooms.

The major influence on the spread of contamination within these areas was unquestionably due to the hiatus between the attack on Mr Litvinenko and the initial response-phase investigation by the police. Cleaning staff within the hotel significantly contributed toward the spread of contamination during this period, as was evidenced by the cascading concentration of Po-210 in the bedrooms from high to low.

Once the recovery phase started, WCC communicated with the specialists from the GDS framework, and identified a process to be adopted for the decontamination works. At this point several events potentially protracted the recovery phase for the Millennium Hotel. Firstly, WCC had no expertise in this area, which became clear in their requirement to adopt methodologies of procedure writing appropriate to asbestos strip operations. In addition, their advisors, collectively known as the Recovery Coordinating Group, had prepared a framework strategy for the remediation works that had a radioactive material concentration level of 10 units (Becquerels per sq cm) for clearance. Unfortunately this was considered a target which was safe to be left on surfaces as it was derived from risk assessment. Clearly the hotel required there to be zero radioactive material remaining following the recovery or clean-up phase.

These two points may seem relatively innocuous in their potential to impact the recovery of the hotel to full operation, but unfortunately this was not the case, and the clean-up was somewhat protracted as a result. Of course, there has been significant learning by all parties concerned in the recovery phase for all premises and businesses contaminated by the attack, and this has been widely published. Local authorities now have specific guidance for counter-CBRN terrorism that falls under the UK's Strategy for Countering International Terrorism (CONTEST 2009), among other guidelines and procedures.



Men's toilets at the Millennium Hotel showing elevated concentrations of contamination.

PREPARED FOR ALL EVENTS

Matom provides protection for staff for evacuation, ways to protect business premises and aid for rapid recovery following a CBRN terrorist attack. It partners with sophisticated security services and trains key staff in response methods and basic monitoring for CBRN contaminants. Staff members are issued with PPE to supervise safe evacuation from premises and also stop potentially contaminated people entering the building. A retained response service is supplied whereby a dedicated team is provided within 24 hours to quantify contamination levels and then decontaminate the building as necessary. Protection and recovery from a CBRN incident can be designed into business continuity planning.

Lessons for protection and response

We now have an understanding of the skill base that services recovery under a GDS-type framework. A business may now ask: "As part of my company's business continuity planning can I account for the GDS service when considering recovery from a CBRN terrorist attack?" The answer here is clearly NO, and any business with knowledge of CONTEST and its supporting guidance will be aware that businesses have responsibility for preparedness when considering safety of employees and premises.

The impact of a terrorist attack regarding business continuity can be equally as impacting even if it is not directed at that company, but directed elsewhere in the vicinity, for example a crowded train station access.

"The major influence on the spread of contamination within these areas was unquestionably due to the hiatus between the attack on Mr Litvinenko and the initial response-phase investigation by the police."

Preparedness must account for such high-risk locations. Matom has recognised this difficulty for business continuity managers, and have addressed this by providing services that assess risk, protect staff, protect office premises and maximise the effectiveness of recovery.

It is recognised that the UK has a limited and pressured operational radiological protection (health physics) resource. The nuclear industry recognises this as a serious concern. The demands of operating nuclear power plants needing programmed supply-chain support for maintenance periods (outages) and the aggressive UK power plant decommissioning programme are just two areas that pressurise the supply chain and tie down almost all of the available monitoring staff that would be utilised in a CBRN dirty-bomb recovery situation.

The consequence of this over the next few years is that recovery following an attack will protract, with inevitable costs to impacted businesses. The Litvinenko attack and recovery provided learning that has been assimilated by the public sectors co-ordinating response to incidents. The means are available for organisations to protect, respond to and recover from a CBRN incident in a controlled manner through the use of expert contractor support as an integral part of their security and continuity arrangements.

M.D. Tuck CRadP has 22 years' operational experience in HAZMAT, particularly in the field of radiological protection, and has advised on high-risk projects in the UK and around the world.

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CLARION EVENTS

READY OR NOT?

Omer Laviv outlines airport and airline CBRN threats and how they can be mitigated

"Tomorrow's threat may, rather will, include the use of chemicals, bacteriological agents, radioactive materials and even nuclear technology."
Dame Eliza Manningham-Buller, MI5 Director General, 9 November 2006.

Aviation terrorism involves hijackings and bombings. The 9/11 attacks revealed how terrorists look for innovative ways to penetrate aviation security measures. Suicide attackers took the lives of thousands of innocent citizens.

This combination of innovative attack methods and suicide terrorists provides a challenge to aviation security experts. CBRN attack scenarios threaten the safety and security of air passengers.

Intelligence reports reveal that al-Qaeda has been looking at ways to launch strategic strikes using CBRN weapons; having made its intentions public and including such tactics in its encyclopedia of jihadi and terrorist training courses.

Airport vulnerabilities

While CBRN weapons differ in methods of use, availability, immediacy of affects, detection measures, containment measures and lethality, they are alike in one respect: on-ground airport terminals and in-flight aircraft cabin are attractive targets for their use. While the RN threat is deemed to be attractive to terrorists when dispersed from an aircraft above a populated area, CB agents can be used in a deadly manner inside airport terminals or commercial flight passenger cabins. This article focuses on the CB threats.

C and B agents when used for terror attacks in airport or on-board passenger planes will have differing effects. Chemical agents such as sarin and hydrogen cyanide are considered to be fast-acting, symptoms will appear in seconds. Biological agents – contagious or non-contagious – are considered to be delayed-action agents, with no initial symptoms; they typically appear after a few days. A bio-terror attack – which could be in the form of a highly infectious passenger – will not be detected in real time.

Airports are natural targets for attacks, with many access ways which do not have security measures aimed at detecting CB agents and explosives. These are rarely in the passenger-congested public areas. An airport's HVAC system can be easily accessed and used to maximise the effect. A ventilation system can quickly spread CB agents around an airport.

Airports utilise extensive security measures, but focused primarily to detect conventional-type attacks and to keep weapons and explosives off aircraft. The current measures are not aimed to counter an attack at the airport terminals (as demonstrated in the Moscow Domodedovo Airport attack in January and at Glasgow Airport in June 2007).

Safeguarding aircraft

Aircraft might be considered more protected against CB attacks. The same systems and procedures that are in place to prevent transmission of diseases via air travel are practically equipped to counter bioterror attacks.

Commercial aircraft have on-board advanced environmental control systems that control cabin pressure, ventilation, temperature, anti-icing and fire and smoke protection. Air is 'sucked' from outside and integrated within the cabin environment. At 30,000-40,000 ft (cruising altitude of a commercial flight) the outside air is clean, dry and particle free. Whether the cabin receives fully circulated air or a 50/50 ratio (as with some aircraft models), it still minimises the effects of C and B agents. It is possible for CB agents to terrorise a commercial flight, it is wrong to regard it as a 'weapon of mass destruction' - weapon of mass disruption is more appropriate.

As C and B weapons are more expensive and difficult to use than conventional explosive devices, we shouldn't panic. We need to conduct further research and to execute more out-of-the-box threat assessments. Airports and aircraft have not been attacked, yet, by terrorists using biological or chemical weapons. Let's make sure we are ready if and when they do.

On-board advanced environmental control systems suck air from the outside into the cabin, minimising the effects of CB release

Major (ret.) Omer Laviv is Chief Operating Officer of Athena GS3 Security Implementations Ltd. He leads the company's "Red Team" activities and has more than 25 years' experience with the Israeli Airport Authority.

THE CBRNE RESPONSE OF THE US MILITARY

Tony C. Williams and Cpt. Bryon Marsh examine standards for first-responder civil support.

The US government relies on its élite WMD response military expertise to develop training and response policy for CBRNe threats. However, first-responder complications exist due to the 1878 Posse Comitatus Acts that do not allow for the US military to respond to an alleged CBRNe event unless a 'non-military agency' is notified and subsequently leads the incident command and response.

Federal limitations

The 1878 Acts substantially limit the powers of the federal government to use the military for law enforcement. It prohibits the Marine Corps, Army, Navy, Air Force and state National Guard from exercising state law enforcement, police or peace officer powers maintaining law and order on non-federal US property. It prohibits federal military personnel and federally authorised units of the National Guard from acting in a law-enforcement capacity within the US, except where authorised by the Constitution or Congress. The Coast Guard is exempt.

While relevant to civil military co-operation, the Act has hindered US ability to respond to scenarios and terrorist attacks. Over the past ten years the bioterrorism response community in the US military has received billions of dollars and stands ready as the most potent bioterrorism response component of any government on the planet – yet it struggles with standardisation issues. The biological pathogen response and scientific community will benefit significantly from standardisation and re-engineering to meet the next decade's requirements for increasing bioterrorism threats.

Responding to BWAs

After the 2001 anthrax attacks the US Department of Homeland Security (DHS) moved to improve and standardise how the nation detects, collects and tests biological threat agents. This effort co-ordinated various federal agencies and has resulted in some positive results, such as the co-ordinated document from the Dept of Health and Human Services (HHS)/Centers for Disease Control (CDC): *Guidance on Initial Response to a Suspicious Letter/Container with a Potential Biological Threat* and the ASTM standards E2770-10 and E2458-10. The advance of technology has also transformed how first responders test unknown substances at point of sample with novel assays once reserved for a fixed laboratory setting. At times these advances have seemed slow to materialise. Nearly ten years post 9/11 we can see these efforts have started to transform our response.

In the late 1960s advancements in technology, techniques and standards transformed the role of the ambulance driver into that of a lifesaver. Progress in technology such as automated external defibrillators, pharmaceuticals, techniques such as CPR, and standards such as governance by accrediting boards, have transformed ambulance services from basic transport to today's modern emergency medical services (EMS). Acute medical care has been projected beyond the traditional confines of the hospital ER into the first contact by EMS personnel. Today's average first-responder Hazmat team shows a similar transformation brought about by technology, techniques and standards. This now allows the extension of testing from fixed laboratories forward to point of sample.

The National Guard Civil Support Team (CST) programme exemplifies this transformation. From ten teams before the 9/11 anthrax attacks there are now 57, one for each state and territory with several larger states fielding two teams. The success of CSTs is due mainly to the long-term investment by the National Guard Bureau to field ISO 17025 accredited mobile laboratories, known as Analytical Laboratory Systems (ALS).

Standardising sampling

Combined with the first-responder sampling guidance of ASTM E2458-10, samples are now split at point of sample –

4th CST strike team in an incident command link-up with the local civilian authority in order to reconnoitre down-range hazards and conduct sampling.

Left: Cobb County Fire department HazMat response personnel collecting samples for recovery for off-site laboratory testing by the CDC's Laboratory Response Network. Right: 4th CST use the new CDC surface-sampling method to collect environmental samples to assess contamination after a simulated BT event.

using a 'Method A' and 'Method B' strategy. Method A is the primary bulk sample collected for off-site submission to the CDC's Laboratory Response Network (LRN); the Method B sample is collected for on-site testing using such assets as a CST's mobile ALS. Method B is effectively a game changer, and for the first time provides the way forward for federal agencies and industry to support on-site testing by first responders with assays specific to their application. These changes are occurring gradually; support is needed to develop techniques and standards for the best use of these new, powerful technologies.

For years the various components of a bioterrorism response rarely trained together; their SOPs were not synchronised – partly due to complex US landscapes of state, county and municipal jurisdictions. Standardisation must start at the top. The three major agencies providing the best vehicle are the first responder community, the FBI and the LRN of the DHS-HHS/CDC. The FBI and LRN are federally funded, naturally providing for top-down standardisation. The first-responder community varies from state to state and county to county and could benefit most from standardisation. We cannot afford to invest in technology without investing in verification capabilities.

Real-time anthrax exercises

From 2006, the Georgia Department of Human Resources, Division of Public Health and the Georgia Army National Guard's 4th CST held bioterrorism response exercises: Operation Vigilant Sample (OVS) – the first documented laboratory-specific US exercises using state and military assets to collect and identify gamma-irradiated Bacillus anthracis spores. Sample collection was accomplished in accordance with the nationally-accepted ASTM Standard E2458-10 *Standard Practices for Bulk Sample Collection and Swab Sample Collection of Visible Powders Suspected of Being Biological Agents from Nonporous Surfaces.* Objectives were achieved and improvements documented to streamline response activities at state and incident command levels.

The OVS exercises justified developing an exercise template for use by other CSTs and their state LRN laboratories and FBI WMD co-ordinators demonstrated in a third exercise in February 2011. OVSIII provided a workable template meeting the US Army's National Guard Bureau's Yearly Planning Guidance for the CST programme and the LRN's *Role of Civil Support Teams in Support of the Laboratory Response Network* integration guidance document.

Standardisation of laboratory analysis and training are key

"The biological pathogen response and scientific community will benefit significantly from standardisation and re-engineering to meet the next decade's requirements for an increasing bioterrorism threat."

Response must be evaluated in total, not just by its components.

The CST programme also receives federal funding and has been bridging the gaps between local response and federal involvement. Recent initiatives such as *The Role of Civil Support Teams in Support of the Laboratory Response Network* define relationships and promote collaboration. Additional emphasis on collaboration, specifically with regards to training, can be found in Section 8 of the ASTM E-2770-10, that provides guidance on responder competency and field exercises. The standard calls for yearly evaluations utilising a proficiency testing programme for field response and that these evaluations should occur in co-ordination with the LRN and FBI.

elements in CBRNe response. Preparation and training across all US government services plus a more streamlined military policy will provide for improved overall management of CBR event response programmes.

• *Tony C. Williams is former Program Manager, US-DOD, Office of the Secretary of Defense, Special Operations/Low Intensity Conflict Policy and Defense Threat Reduction Agency,*

• *CPT Bryon Marsh is the Science Officer with 4th CST-WMD, Atlanta, GA. As Medical Operations Officer he was responsible for moving environmental samples from field to laboratory.*

2004 Olympics. Athens.

A LESSON IN INTEROPERABILITY

Ioannis Galatas looks at procedures and equipment for major international events.

The 2004 Olympic Games in Athens was the first summer Olympiad after 9/11. A master CBRN response plan needed to be created from scratch. Medical readiness was poor and many lessons were learned. The main partners were public, military and international sectors. Operationally, the public sector was by law the predominate partner; the military would be an adjacent asset should the situation progress out of control or the event be too big to handle by the State alone. For medical response, major civilian hospitals in Athens and other Olympic cities were to handle mass casualties in case of a terrorist CBRN event. The NATO NBC Battalion assisted both sectors in case of a real WMD terrorist event.

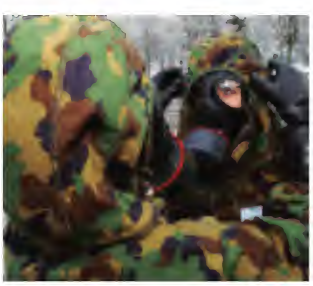
The above looked good on paper but interoperability posed problems that nearly compromised the whole mission and demanded strategic movements mostly from the military side. The most important obstacle was the general attitude of civilian entities involved "It will not happen to us!". Even after 9/11 they were reluctant to admit that this was the new reality. And CBRN defence for such an event required a lot of money that would further exaggerate the already out-of-control national budget.

Enter the military

The medical/hospital/public health entities were much more primitive. They had minimum knowledge regarding CBRN threats, consequences and crisis management – totally different from peacetime medical crisis.

The attitude of medical people participating in 'hot' and 'warm' operational zones was lacking. With some exceptions, they refused to get involved – even threatening to go on strike during the Games. The solution was provided by the military, that formed two units: one for field/medical operations in support of civilian first responders and another deployed at the Army General Hospital of Athens.

The Olympic Hospital CBRN Response Unit was the only specialist hospital-based unit deployed during the Games which I was proud to command. It comprised 65 physicians, nurses and NCOs, mainly with Organisation for the Prohibition of Chemical Weapons help. All three military hospitals in Athens were included in the Olympic Hospitals list mainly because the military medical system would never go on strike.



Deployment site at the Army General Hospital of Athens.

Left: Pre-Games training of the Olympic Hospital CBRN Response Unit at ABC Zentrum (Swiss NBC Training Centre) in Spiez, Switzerland. Right: Olympic Hospital CBRN Response Unit deployed at the Army General Hospital of Athens, Greece (First Responders Decon Line).

The NATO NBC Battalion was stationed in the city of Chalkida approximately 88 km from Athens centre. Despite limited introductory meetings there was no common acclimatisation training or sharing of modus operandi for a real terrorist CBRN incident and the location chosen was non-strategic.

The above-named three entities operated more or less independently and they were lucky enough not to be called to perform active duties. Lack of interoperability in a CBRN event would skyrocket the consequences for all communities involved.

Improvements post-2004

After the 2004 Games, the two military units merged to form a Joint CBRN Platoon – a huge gain for the military. The civilian sector gradually returned to the 'NBC – No Body Cares' era. Problems identified regarding medical/hospital CBRN readiness are more to do with dealing with the actual threat than with the organisational concepts of the hosting countries. It is impossible to train all doctors and nurses on how to deal with new threats, and to have all hospitals prepared to accept mass contaminated casualties. We should focus on training as many medical people in as many hospitals as possible. Introducing 'Medical CBRN Defence' or 'Terror Medicine' courses into medical school curricula would greatly advance the differential diagnosis capabilities of frontline health professionals who would be needed to deal with a real CBRN terrorism incident in a megapolis environment.

Brig. Gen. (ret'd) Ioannis Galatas is CBRN Scientific Co-ordinator at the Research Institute of European-American Studies, Athens.

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